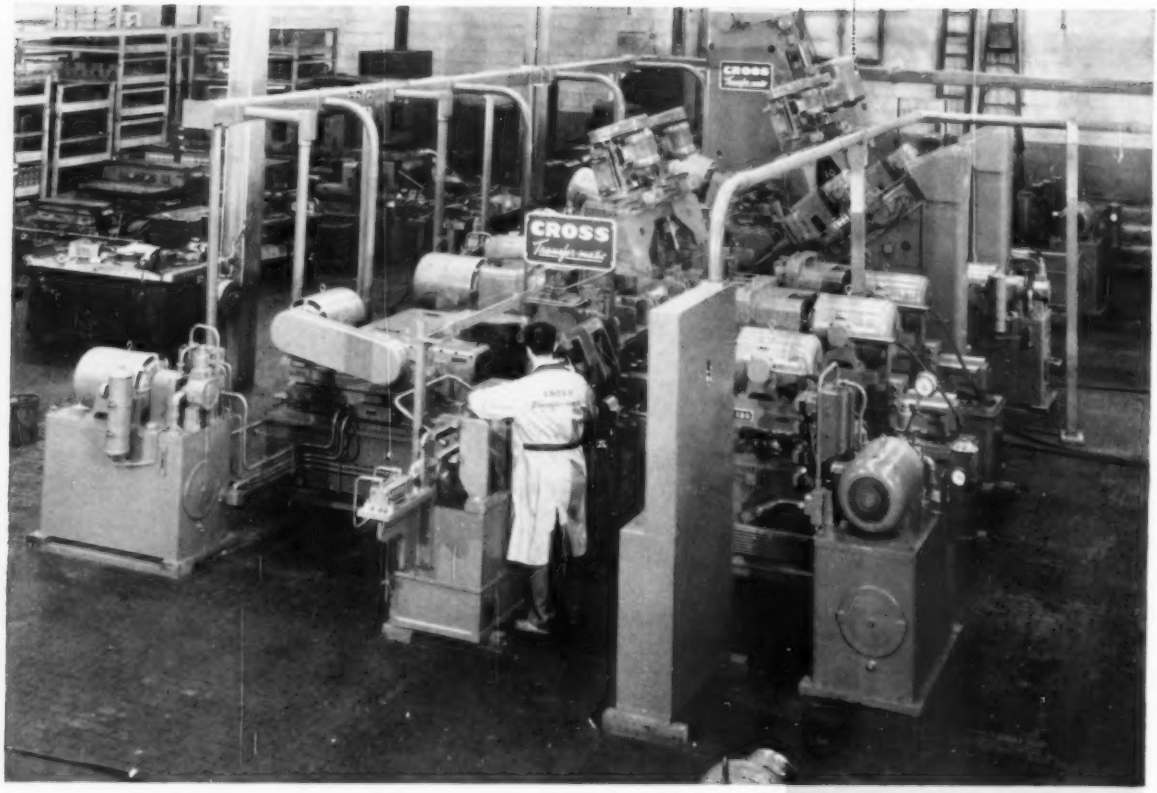
ORDNANCE

LAND • SEA • AIR • SPACE

T195 takes the plunge

SEPTEMBER-OCTOBER 1959



Why Cross chose Timken® bearings for all 148 drill spindles

THIS huge Cross transfer machine drills and taps holes in automobile engine blocks at new highs in speed and accuracy. To assure maximum user economy and machine life, Cross engineers chose Timken® tapered roller bearings for the machine's 148 drill spindles Here's why:

1) *They maintain precision longer.* Timken bearings are geometrically designed to give true rolling motion, precision manufactured to live up to their design.

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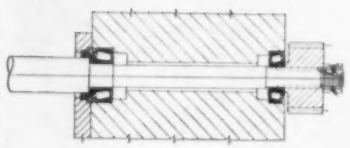
When you use a machine with Timken bearings, you get all the *extra* benefits of Timken Company leadership in tapered roller bearing design and in engineering service. We maintain the industry's most modern laboratory to test bearing applications. To get better machines, make sure they're Timken-bearing-equipped. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

How THE CROSS CO. mounts 148 drill spindles of its Transfermatic machine on Timken bearings to give longer bearing life, maintain accuracy.



This symbol on a product means its bearings are the best.

WHEN YOU BUY TIMKEN® BEARINGS YOU GET...

1. Quality you can take for granted
2. Service you can't get anywhere else
3. The best-known name in bearings
4. The pace setter in lower bearing costs

BETTER-NESS rolls on

TIMKEN®

tapered roller bearings

First in bearings for 60 years

ORDNANCE

LAND·SEA·AIR·SPACE

Forty Years of Leadership in American Armament Preparedness

VOL. XLIV SEPTEMBER-OCTOBER 1959 NO. 236

The Cover.—*The new 105-mm. self-propelled howitzer T195 shown going through the water test at Aberdeen Proving Ground, Md., is an aluminum-armored amphibious weapon of high mobility and firepower (Army photo).*

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ORDNANCE is published bimonthly by the American Ordnance Association, Mills Building, Washington 6, D. C. Second-class postage paid at Washington, D. C., and at additional mailing offices.

Subscription rate: Continental United States and possessions, $5.50 annually in advance; foreign, $7.00.

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Six weeks' notice before next publication date required for change of address.

FIREPOWER, formerly published separately by the American Ordnance Association, is combined with ORDNANCE magazine.

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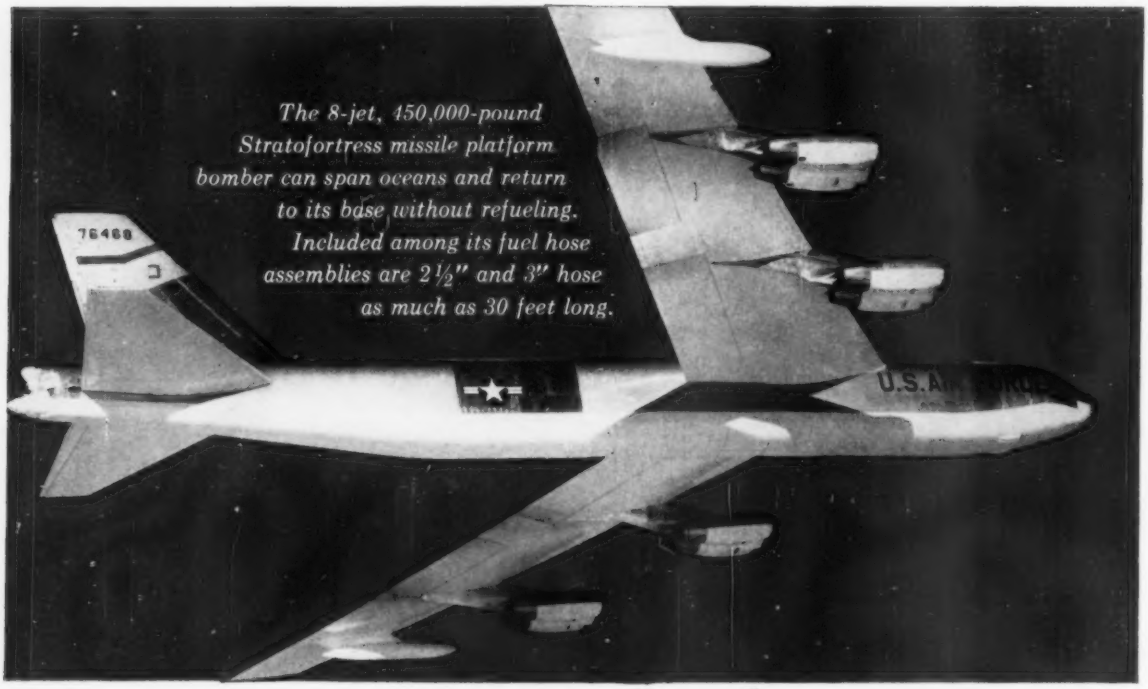


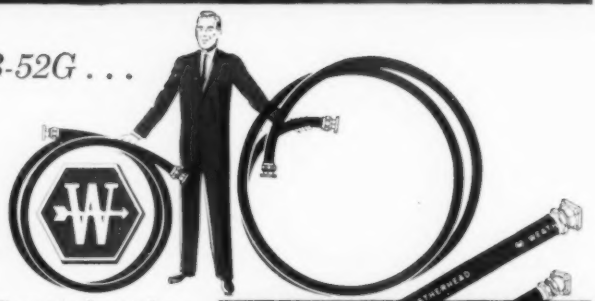
The 8-jet, 450,000-pound Stratofortress missile platform bomber can span oceans and return to its base without refueling. Included among its fuel hose assemblies are 2½" and 3" hose as much as 30 feet long.

75 Fuel Line Assemblies on B-52G . . .

Completely New . . .

Developed and Produced by

WEATHERHEAD



The Weatherhead fuel line system for Boeing's B-52G meets heretofore unknown requirements in terms of operating characteristics, material properties, light weight and unusually large range of sizes (1½" to 4" I.D.) Approximately 75 different assemblies provide continuous distribution of fuel in the integral wing and fuselage tanks to the eight jet engines. The special hose is impervious to the JP-4 or JP-5 fuels employed, even where it remains immersed in fuel.

In developing the entirely new hose assemblies, Weatherhead worked on the specifications with Boeing engineers. Shortly afterward, Weatherhead had established mass production of the full range of qualified assemblies.

This is an example of how Weatherhead smoothly synchronizes its vast research and development, engineering and manufacturing facilities to originate and supply special needs within tight timetables. Whatever your fluid system requirements, look to Weatherhead for assistance from concept through production.

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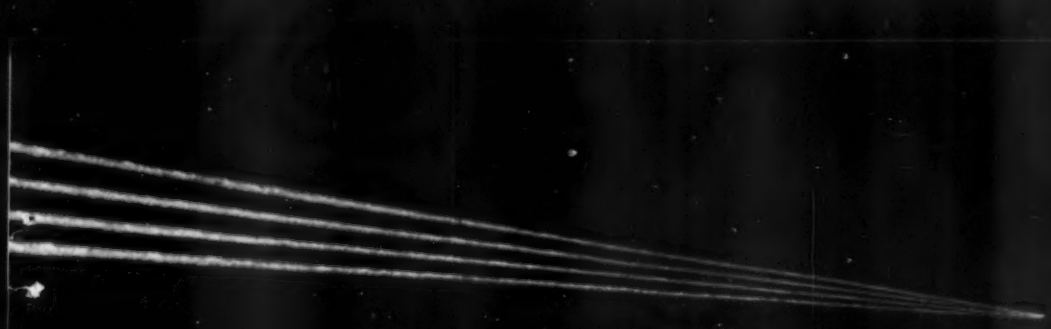

TEAM POWER

New weapon in the Air Force arsenal

The mightiest of air powers, the United States Air Force, has added a new kind of weapon to its arsenal—*teamwork* of private industry.

Defense of the free world requires unprecedented scientific achievements—new weapons systems so advanced they demand the specialized capabilities of many organizations.

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Recently the specialized talents of eight organizations were joined together by Hoffman Laboratories Division as systems manager in developing a complex electronic reconnaissance system for the Air Force. The success of this program is proving the value of combining the talents of several companies to meet the requirements of today's complex weapons systems.

This kind of teamwork transforms healthy competition into powerful cooperation . . . providing better answers faster and at less cost to the nation in terms of time, money, and manpower.

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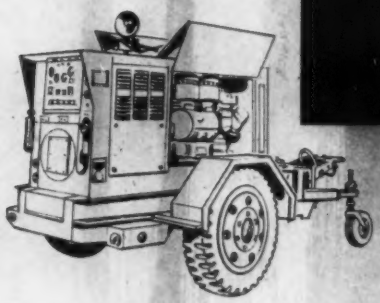

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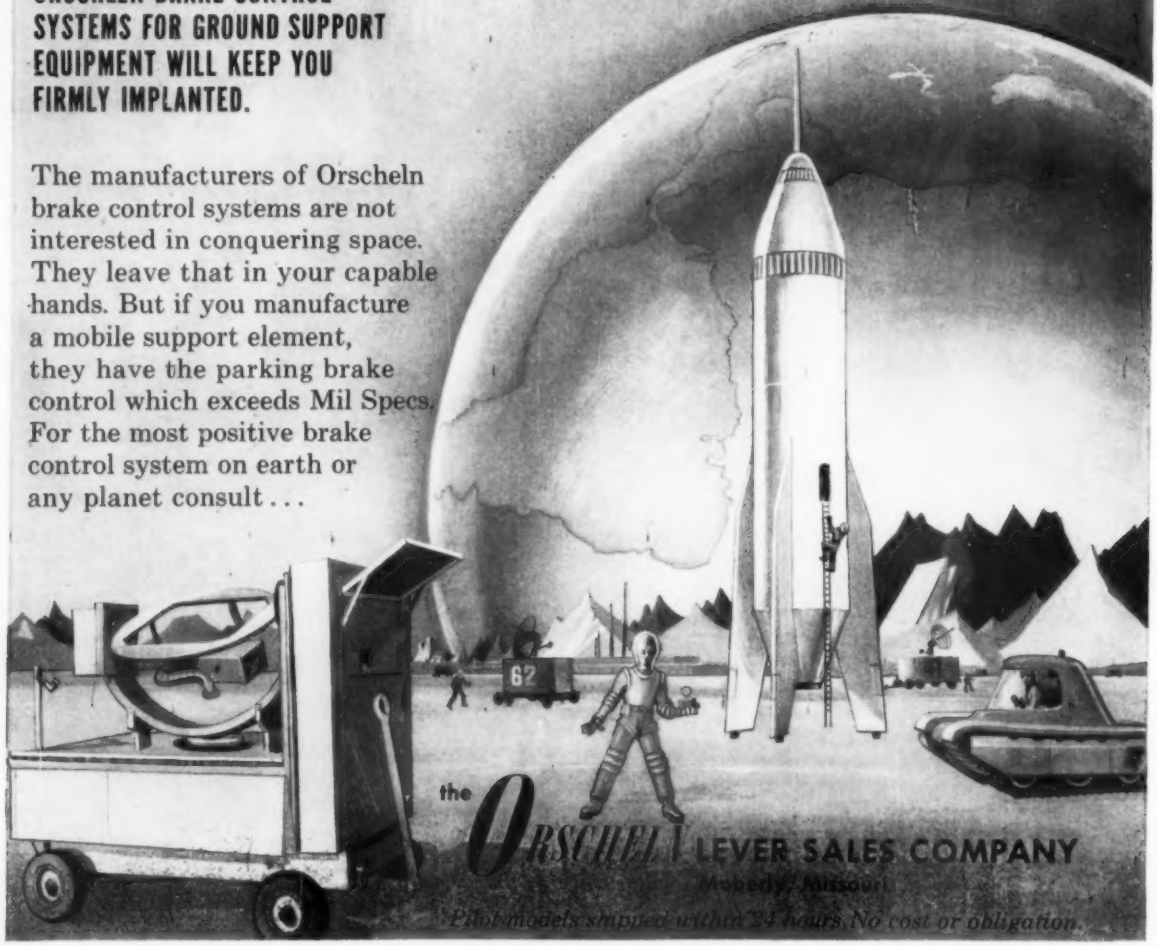

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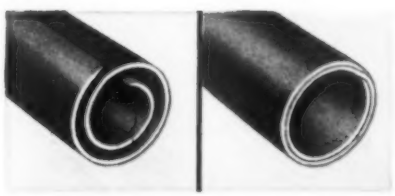

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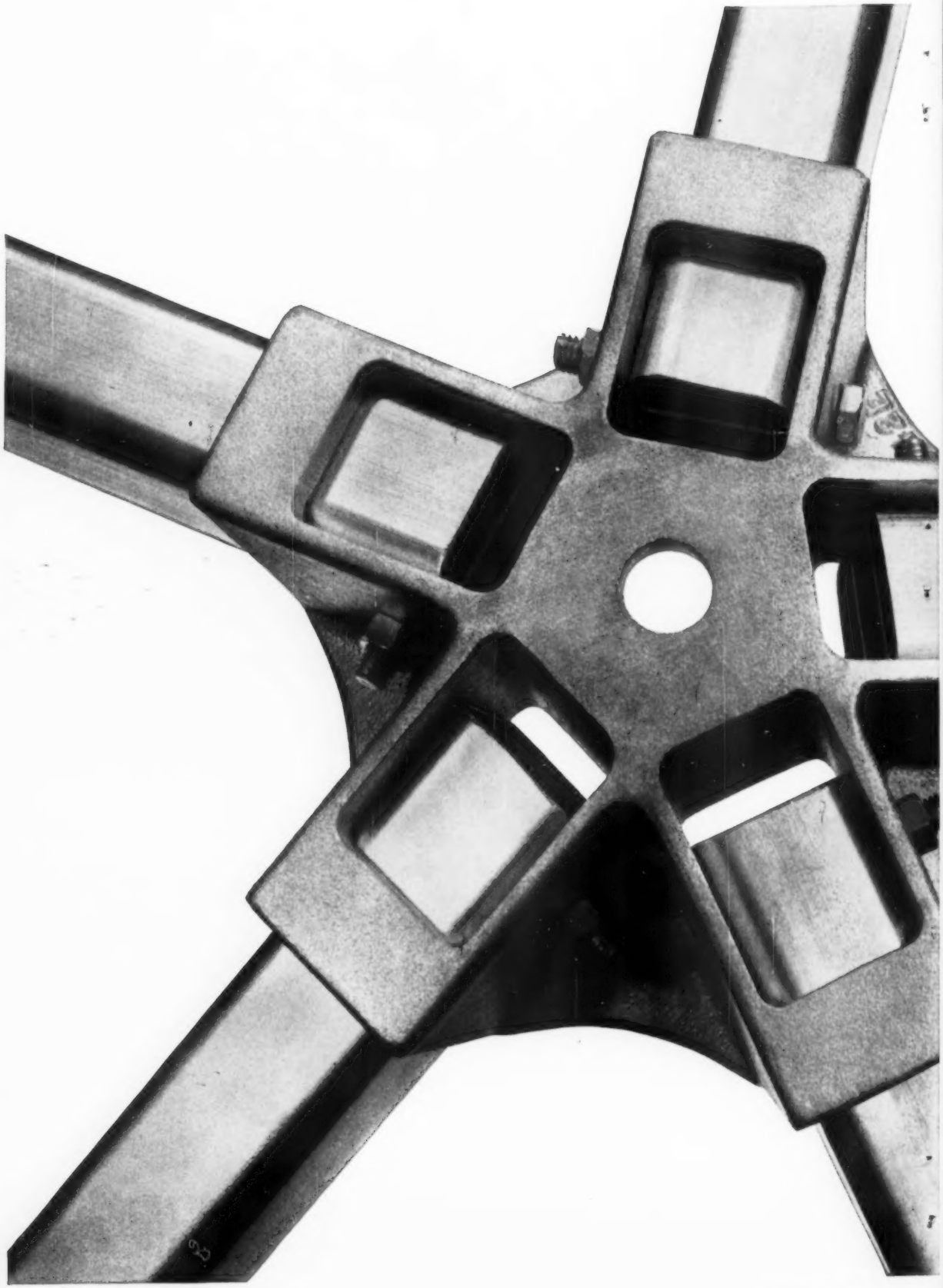

One of the many Q-E-D* geodesic-type dome shelters built for the U. S. Marine Corps by Magnesium Products of Milwaukee, Inc.

The marines go modern . . . quartering themselves and their equipment in portable, simple-to-erect geodesic-type dome shelters like the one shown above. It was designed and engineered by Magnesium Products of Milwaukee, Inc. And strong, lightweight Flynn aluminum extrusions were used to form the framework.

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Flynn extrusions form framework for sturdy, mobile Marine Corps shelters

It's tough and long-lasting as well as light and handy to work with. It makes assembly fast and simple. Also, aluminum parts are easy and economical to ship.

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*Quick-erect dome

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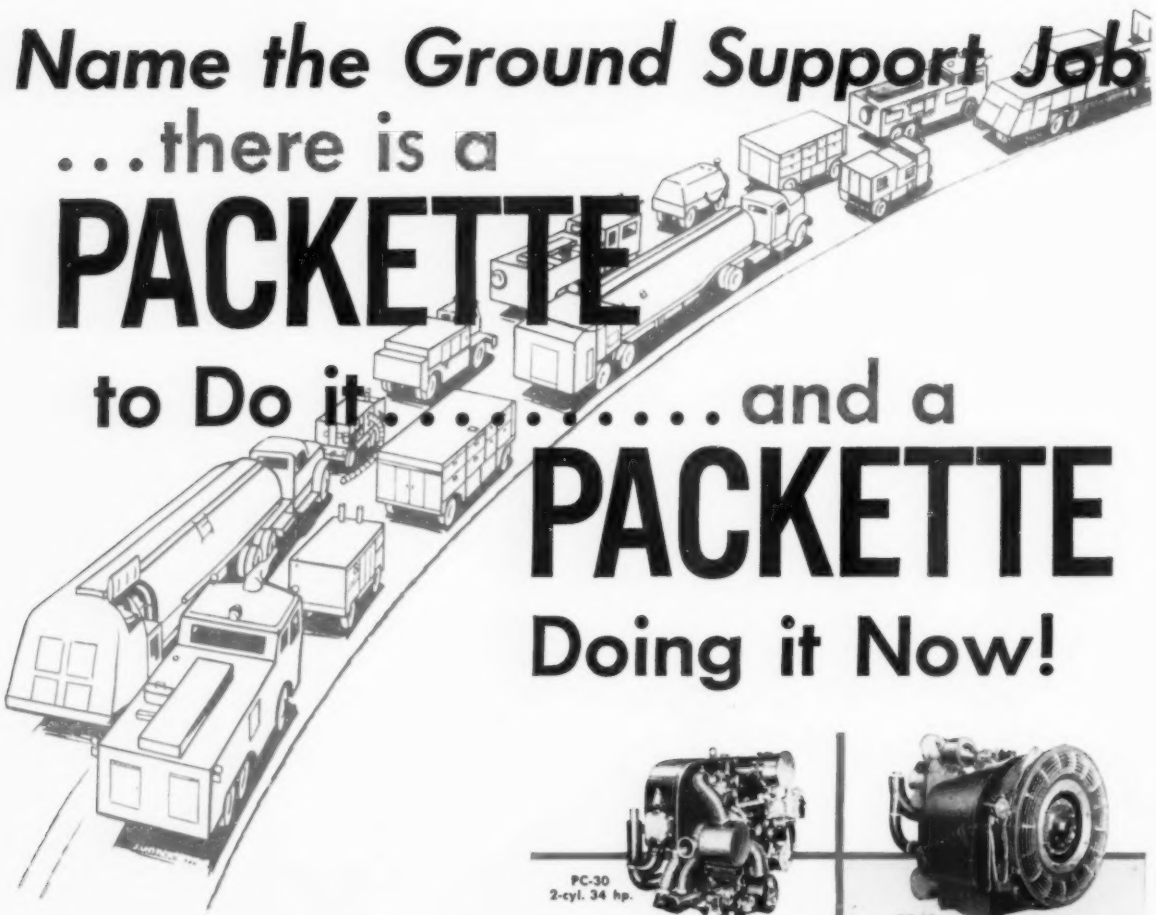
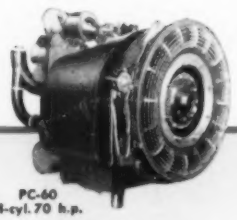
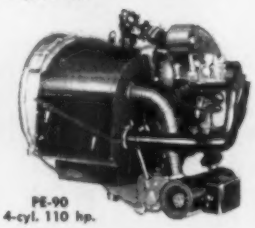


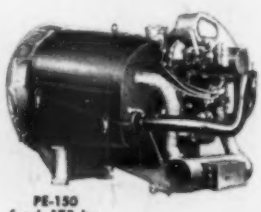
PC-30
2-cyl. 34 hp.



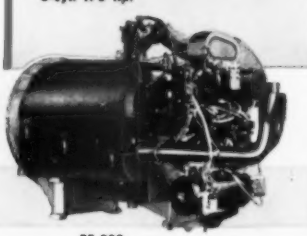
PC-60
4-cyl. 70 h.p.



PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.

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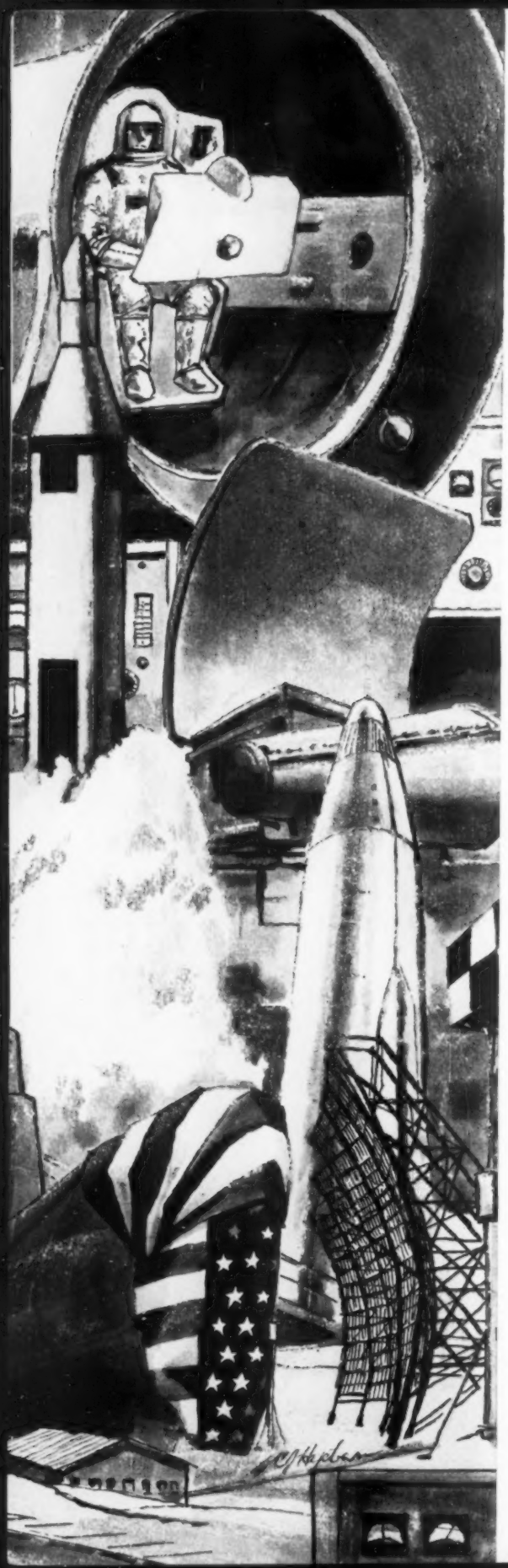

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- Competent systems engineering
- Continuous program evaluation
- Efficient specification and procurement

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- 25′ telescoping boom can be extended to 47′
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- Hydraulic outriggers
- Gas or diesel power
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- Hydraulic cable hoist
- Boom swings 220°
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- Rear trunnion steer
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- Outlifts all other 3-wheel cranes over-the-side!
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- Full reverse transmission
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- Boom raises to 50° from horizontal

Available with wide range of accessories for added versatility!

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Carry it by air, drop it by parachute, run it over the most rugged terrain—or add an outboard motor, and power it through water! The all-new XM-410, designed in aluminum and built by Chrysler, goes anywhere under any conditions.

Made with strong, lightweight Reynolds Aluminum, this new vehicle weighs less fully loaded than the standard steel truck weighs empty. Air transportable, it is rugged enough to take the jolts and pounding of an air drop. And rustfree, corrosion-resistant Reynolds Aluminum fits it for "sea duty", too. As is true in so many commercial and military developments, Reynolds contributed *more* than aluminum to this new vehicle. Reynolds engineers worked closely with Army Ordnance and Chrysler, providing technical services and know-how on the best use of aluminum.

For specific information on how Reynolds Aluminum can solve problems in product improvement and production efficiency, write to the *Reynolds Metals Company, Box 2346-TO, Richmond 18, Virginia.*

ALPHA

. . . MANAGEMENT BRAIN FOR SPACE AGE SYSTEMS

Alpha Corporation was established to expand upon Collins Radio Company's extensive program of design, engineering and installation of complex communication and navigation systems. The entire systems division of the parent company, including its executives and space age specialists, is being consolidated with Alpha. Further, responsibility for the vast projects for government and industry in the Collins systems program is being assumed by Alpha . . . with its greatly augmented staff of designers, engineers, scientists and constructors. Alpha is geared to handle turnkey technical projects of all magnitudes . . . on this continent and in foreign fields. In addition to intricate electronic equipment, Alpha will design and construct related roads, towers and buildings. Alpha trains client personnel or staffs and operates finished installations. Alpha, using the best equipment from throughout industry . . . is the hallmark of world-wide systems management dependability.

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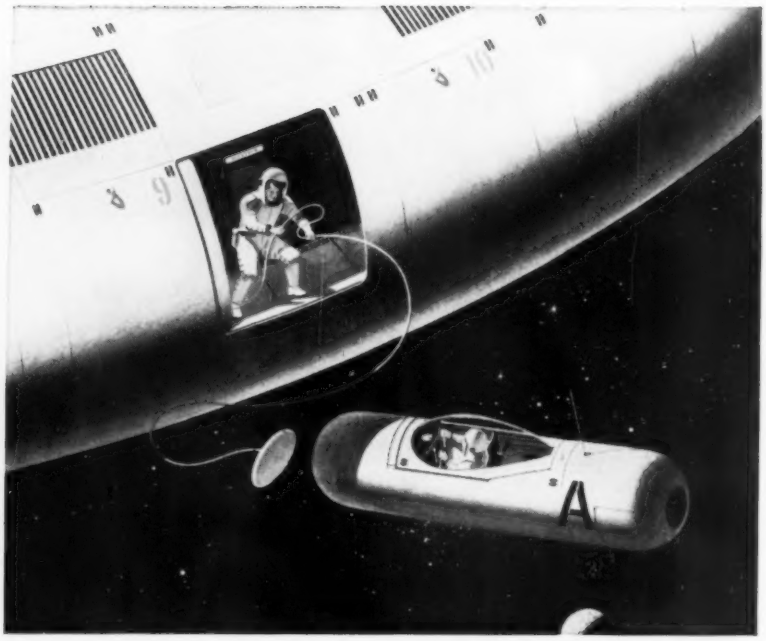
Alpha capabilities include technical systems management in all fields, with special emphasis on: • Space vehicle tracking and communication
Test range instrumentation and communications • Voice, teletype and data transmission • Aircraft modification and overhaul
Integrated shipborne, airborne, and ground communications • High capability remote control and switching

COUNT DOWN

for the conquest of space



WHAT KIND OF ENGINE FOR A SPACE-TAXI?

It takes a unique engine to jockey a space-taxi in for a landing on an orbiting space station—one that will give a space pilot instant control and precise maneuverability.

Such an engine is the fully controllable rocket engine—ideal for space travel yet as easy to operate as an automobile engine.

The rocket engines are ready now

Although the space-taxi is still a gleam in an engineer's eye, the controllable rocket engine is available now...and has immediate application for existing aircraft. The pilot of a plane with auxiliary rocket power can switch it on for sudden, swift acceleration at high altitudes . . . the aircraft's air-breathing turbojets supplying power for ordinary flight operations. This is the mixed-power theory. Since World War II several mixed-power concepts have been developed in foreign countries, including Russia, France and England.

Extra power for today's aircraft

Rocketdyne already has designed, tested, and manufactured rocket engines for mixed power applications. The AR-1 rocket engine is a liquid-propellant system, as are the large power plants for the Atlas, Thor, Jupiter, and Redstone ballistic missiles. The AR-1 passed stringent flight tests as a supplementary power plant on modern jet aircraft. Substantial improvements over normal near-sonic speed and 50,000-foot altitude capabilities were demonstrated in more than 100 test flights.

The AR-2, second in a series of four rocket-engine models developed by Rocketdyne, is a fully-throttleable engine that provides varied thrust. Using fuel from the airplane's tanks—which automatically ignites with hydrogen peroxide—these engines have full stop and restart capability.

More value for taxpayers' money

The auxiliary rocket engine gives present aircraft superperformance capabilities at a relatively low cost. It provides the increased speed and maneuverability that could spell the difference between the success or failure of an intercept mission. Almost any existing jet aircraft, as well as those now on the drawing board, can be adapted readily for AR engines.

Looking forward to tomorrow

Beyond a doubt, rocket power has a leading role in the Free World's future. Rocket-propelled airplanes, such as the X-15, will pave the way for man's entry into Outer Space. The multi-million-pound-thrust systems that are now under development at Rocketdyne will be man's means to explore interplanetary Space. But meanwhile, these rapid advances in rocketry can add great strength to America's present deterrent arsenal.

THE MEASURE OF ROCKET POWER

The liquid-propellant AR rocket engines are "static tested" at Rocketdyne's field laboratory to measure thrust and performance.

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The sum total of the skills involved in the conception, design, development and manufacture of complete optical systems frequently cuts across many fields. Kollmorgen combines technical skill and complete facilities for highly precise work in optics, mechanics and electronics. From the engineering design and mock-up stages through development, manufacture and final testing, Kollmorgen can handle the *whole* job.

Your remote viewing, inspection and testing problems can receive the careful attention of this completely integrated facility. A simple sketch is enough to get us started. Inquiries should include such information as the size and nature of the objects to be observed, the presence of adverse conditions such as temperature extremes, blast and explosion, radiation, etc. For information on particular instruments, please write Dept. 229.

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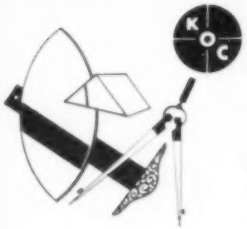
Continuous strip fuel inspection cameras. Hot cell periscopes, underwater periscopes.

Periscopes can be provided with Radiation Resistant Optics, Internal Radiation Shielding, Corrosion Resistant Materials, Pressurized Construction, Interchangeable Viewing Heads, Interchangeable Eyepieces, Microscope Relays and Camera Attachments.

MISSILE PERISCOPES

These bunker-type periscopes are designed by Kollmorgen to customer specifications. They allow close, detailed observation during launching, static tests and fueling operations without endangering the viewer. As in all Kollmorgen periscopes, the excellent light-gathering power of these instruments makes them easily adaptable for photography or television purposes. All are hermetically sealed and maintenance-free.



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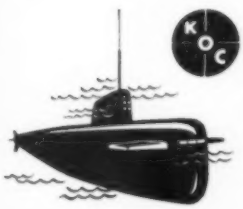
Kollmorgen's well-equipped optical shops produce all types, shapes and sizes of lenses, prisms and mirrors to meet the most exacting requirements of industry and defense. Quantities from one of a kind to production runs of thousands. Individual elements or complete optical systems.



SUBMARINE PERISCOPES

The Nautilus and her sister ships of the atomic fleet, like almost all other U. S. submarines, are equipped with periscopes designed and manufactured by Kollmorgen.

SPECIAL PRODUCTS

Borescopes—in lengths from a few inches to forty feet, diameters from .100" to two inches. Motion picture and television lenses. Riflescopes for the military. Optical training devices. Collimators. Transit optics. Electronic devices (classified). Aerial camera and bombsight lenses.

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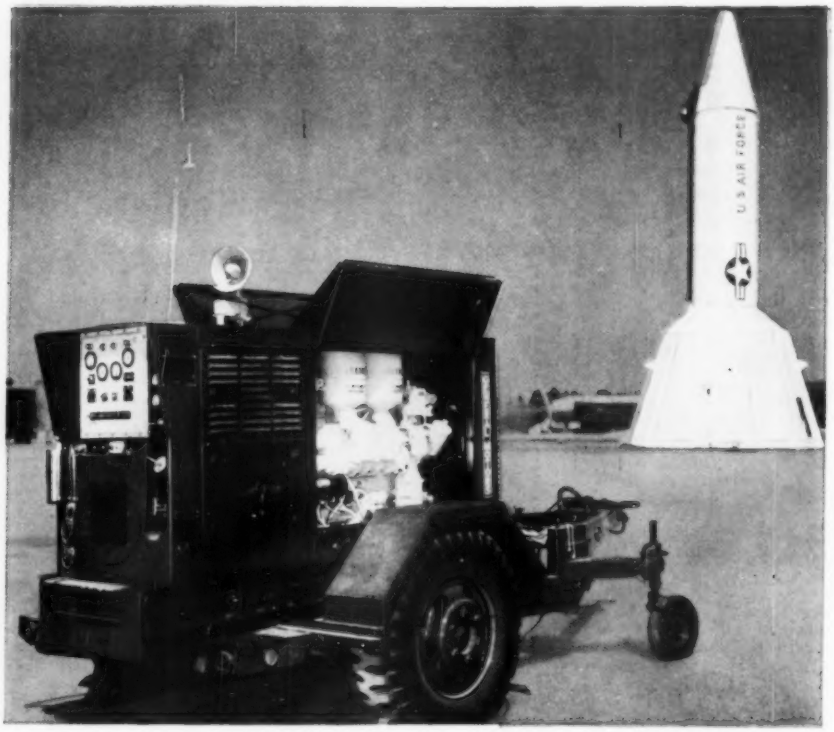
GM DIESEL 100-KW. PRECISE-POWER GENERATOR SET at Jupiter Missile launching site

all purpose power line

(20 to 1650 H.P. in only 3 cylinder sizes)



Developed in conjunction with the U. S. Army Corps of Engineers and the Army Ballistic Missile Agency, this GM Diesel Precise-Power Generator Set combines the time-proved GM "6-71" 2-cycle Diesel engine with a 100-KW. Delco generator equipped with a specially designed regulating system for utmost accuracy.

Weight of the unit is kept to a minimum (only 5,800 pounds) through extensive use of aluminum in both engine and generator components.

Starts and operates in –65° ambient—arranged for remote starting—load-sensing hydraulic governor on engine. *Operates satisfactorily on either Diesel or JP fuels because, unlike some 4-cycle Diesels, GM unit injectors do not require fuel oil with high lubricating qualities.*

This new 100-KW. Diesel Engine-Generator Set is designed to meet the most exacting performance standards in supplying power for radar, ground support and other facilities for various missile programs of the U. S. Army, Navy, Air Force and Marine Corps.

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These compact, highly mobile units are key components of the GM Diesel All-Purpose Power Line of engines and generator sets which are widely used, for example, on the DEW line, in naval transports, personnel craft and many other types of equipment • Engine and parts interchangeability permits standardization with other GM Diesels used in trucks, cranes, compressors, LOX plants and other equipment • Lightweight for maximum mobility—easily mounted on Army-type 2- or 4-wheel trailers • Trouble-free operation—long life without overhaul • Models of varying capacities in 50-, 60- and 400-cycle alternating current as well as direct current available • Easily paralleled.

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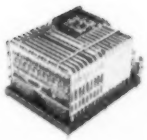
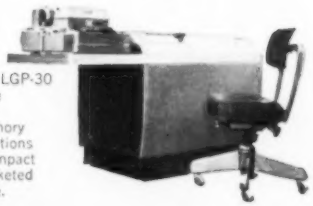
In the missile: small transistorized general purpose digital computer for flight control and guidance. 2000-word magnetic-drum memory.





On the ground: LGP-30 general purpose computer with 4096-word memory for such applications as design and impact prediction. Marketed by Royal McBee.

At every stage, the success of a missile program depends upon a computer. Librascope computers, components, instruments and systems give right answers from original concept to final evaluation.

THE FIRST STAGE: Workable designs. **SECOND STAGE:** Trajectory and engineering computations required long before the launching. **THIRD STAGE:** Control, guidance; impact prediction. **FOURTH STAGE:** Data reduction and analysis. ■ Recognizing still a fifth stage, Librascope determines reliability in the lab. Environmental tests check equipment for temperature, shock, vibration, pressure and other "real" conditions likely to affect performance. Only positive answers will release Librascope equipment for field use.

MISSILE COMPUTERS

For information on career opportunities at Librascope, write Glen Seltzer, Employment Manager.

Librascope's technical ability to meet exacting requirements has ably served our many military customers in the development of missile programs. ■ For further information on Librascope's computer capabilities for missiles write:

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GROUND SUPPORT EQUIPMENT

A Proven Kearfott Capability – Kearfott's prominence in the design and production of ground support equipment is a result of 15 years' experience in producing precision servo systems, computers, gyro reference systems and inertial guidance equipment. Kearfott test equipment is designed on modular principles which increase flexibility and economy and eliminate the obsolescence factor since modules can be readily modified or replaced. Modules are designed to be compatible with one another, thus providing test capabilities for a wide variety of applications.

Inertial Guidance System Test Console

IN-PLANT TEST EQUIPMENT: Rack-mounted modules comprise the necessary metering circuits, signal generators and power supplies, switching circuits and junction boxes to perform the following tests on inertial reference systems:

Voltage and phase • Current • Heating cycle checks • Verticality of platform in ground erection mode • First order erection time in ground erection mode • Measurements of platform roll and pitch output angles in ground erection mode • Measurements of free drift of platform in azimuth in ground erection mode • Measurement of azimuth gyro torquer scale factor in ground erection mode

FIELD-TYPE TEST EQUIPMENT: Modularized, self-contained unit that provides all power and signal voltages to operate, test or trouble-shoot a gyro. All inputs to and outputs from the gyro are accessible at convenient jacks where connections to measuring equipment can be made, thereby enabling operator to evaluate gyro performance completely. Modules are slide-mounted for ready access if repair, modification or product improvement replacement are required. This portable equipment performs these basic tests:

Insulation resistance • Warm-up time • Torquer scale factor measurement Gyro transfer function • Free drift • Gimbal offset drift • Continuity Signal Generator Null • Phasing • Gyro drift • Fixed torque restraint

Floated Gyro Test Console

Scanalog 200-Scan
Alarm Logging System

GENERAL PURPOSE DATA PROCESSING: This data handling system provides a reliable, precise means of monitoring, logging and performing an alarm function of up to 200 separate temperature, pressure, liquid level or flow transmitters. Manual controls are provided for scanning rates, automatic or manual logging, data input relating to operator, time, day, run number and type of run. 200 numbered lights, corresponding to specific points being maintained, provide a visual "off normal" display for operator's warning. This system has growth built in and can be expanded in capacity to 1024 points and in scanning rate to 2000 points per second.

Write for complete information on Kearfott's ground support equipment.

Engineers: Kearfott offers challenging opportunities in advanced component and system development.

VTVM-PSVM

High-Speed
Precise Angle
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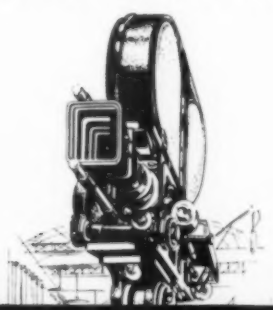
40th ANNIVERSARY *of* **MITCHELL CAMERA CORPORATION**



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ATOMIC ENERGY

New Synchrotron

A 12.5 billion electron volt particle accelerator to probe the structure of matter is being constructed at the Argonne National Laboratory near Lemont, Ill. It will be operated by the University of Chicago under contract with the Atomic Energy Commission.

This zero-gradient synchrotron will propel protons to very high energies for the bombardment of nuclear targets. The machine will have two basic purposes: (1) to serve as a source of a wide variety of subatomic particles and (2) to serve as a tool for investigating the basic properties of these particles.

In operation, protons will first be accelerated to 800 kilovolts by a standard high-voltage source. From there they will go into a linear accelerator—a smaller atom smasher which accelerates particles in a straight line rather than whirling them around in a circle.

The protons will attain 50 million electron volts in the linear accelerator and then will be introduced in short, regulated bursts into the synchrotron which will accelerate the protons to 12.5 billion electron volts in one second.

Antimatter Particles

Photographs exhibiting the presence of "strange" particles of antimatter called "antilambdas," have been taken in the new 6-foot bubble chamber at the University of California's Lawrence Radiation Laboratory. These photographs are the first record of the complete reaction containing the antilambda, including the particle which started the chain of events.

The antilambda belongs to a species of particles called hyperons. It has a mass of 2,180 electron masses. It has no electrical charge. There is only one other member of the lambda species, the ordinary lambda, which is also neutral in charge.

Observation of the antilambda means it is probable that other previously unobserved particles of antimatter—for example, the antisigma—also will be seen in the big bubble chamber. Previously, it had been thought that the antilambdas were produced in the bevatron in such small numbers as to prevent their detailed study.

The new subnuclear unit is the third particle of antimatter to be created and discovered with the bevatron. Earlier ones are the antiproton (discovered in 1955) and the antineutron (1956).

Antiparticles are "building blocks" in a bizarre state of matter constituting a kind of "mirror image" of the ordinary matter of which the earth is made. The particles of such matter have properties—such as electrical charge, spin, etc.—that are opposite to those of conventional matter.

Atomic Defense Agreement

The Agreement for Cooperation on the Uses of Atomic Energy for Mutual Defense Purposes, which stems from the 1958 amendment to the United States Atomic Energy Act, will facilitate closer collaboration between the United States and Canada in planning and implementation of common defense arrangements.

Terms of the accord authorize exchange of classified information on joint defense plans, military reactors, and employment of and defense against nuclear weapons. Also provided for is the transfer to Canada of U. S.-produced nonnuclear parts of atomic weapons systems.

The terms recognize that the Agreement will advance the mutual security of the two countries and relate the cooperation to their joint participation in international defense arrangements.

The United States and Canada already are cooperating in the field of atomic energy under two agreements: one for exchange of information for mutual defense purposes, and the other for cooperation in the civil uses—both signed June 15, 1955.

Gamma Food Irradiator

The Atomic Energy Commission is negotiating a contract with the Curtiss-Wright Corporation of Princeton, N. J., for construction of a large gamma food irradiation facility to become part of the U. S. Army Ionizing Radiation Center at Sharpe General Depot, Lathrop, Calif.

The proposed contract is to cover development, design, construction, and test operation of a gamma facility to be known as the high-intensity food irradiator (Hi-Fi). Upon its completion and test operation the facility is to be turned over to the Army for use by the Quartermaster Corps in connection with its food preservation project at Lathrop. The project is scheduled for completion by mid-1960 and is estimated to cost about $2,000,000.

The Hi-Fi's source of radiation will be approximately two million curies of radioactive cobalt 60. The material, represent-

Crosley helps put the "Sunday Punch" in POLARIS

Making sure the Navy's *Polaris* missile detonates at the right time and at the right place is a prime responsibility of Avco's Crosley Division.

A long record of success in the arming and fuzing of many different types of ordnance brought Crosley the Navy Ordnance Laboratory's prime contract for this difficult assignment.

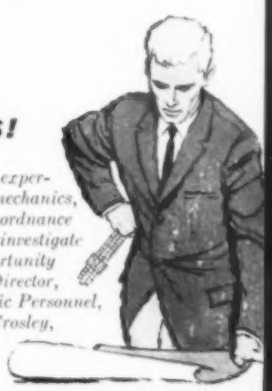
Since first undertaking the task, Crosley has expanded its *Polaris* development work, without once losing step in the demanding *Polaris* timetable.

Arming and fuzing is just one area in which Crosley contributes to the development and performance of missiles. It is the country's leading producer of Command Receivers for missile-range safety applications and for high-performance drones and decoys. It is an important subcontractor to Hughes Aircraft on the *Falcon* missile. Crosley also has contributed to the development of the *Jupiter*, *Sergeant* and *Redstone* missiles.

Crosley's technical competence, dependability, and coordinated project administration are ready to serve the Free World's defense requirements wherever needed most.

For more information, write to: Vice-President, Marketing—Defense Products, Crosley Division, Avco Corporation, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco / Crosley



ENGINEERS!

Creative research and development engineers experienced in electronics, mechanics, weapons systems, and ordnance warheads are urged to investigate the wide range of opportunity at Crosley. Write to: Director, Technical and Scientific Personnel, Dept. O-99E, Avco Crosley, 1329 Arlington Street, Cincinnati 25, Ohio.

ing an amount several times greater than all the cobalt 60 now in use in the United States, will be produced in reactors at the Commission's Savannah River Plant, Aiken, S. C.

Walter Reed Reactor

A 500,000-watt nuclear-energy reactor for biological research and medical treatment has been designed for installation next summer at Walter Reed Army Medical Center. The reactor will be used specifically for biological research at the Walter Reed Institute of Research and for treatment of patients at Walter Reed Army Hospital. It will be the largest atomic reactor available for treatment of general hospital patients and will produce gamma rays, neutrons, and radioisotopes.

The reactor is a "solution" type, which gets its name from the atomic "fuel" consisting of about seven gallons of uranyl sulphate solution, highly enriched in uranium 235. The splitting or "fissioning" of uranium atoms in the fuel produces the neutrons and gamma rays for biological research and medical treatment. The fuel solution is contained in a 16-inch diameter stainless steel sphere or core.

The reactor core will be installed inside an 8 x 5 x 5-foot stack of graphite "logs" shielded by five feet of high-density concrete. Over-all dimensions of the 450-ton reactor are approximately 20 feet long, 16 feet wide, and 26 feet high. The reactor will be self-contained, with no harmful particles, fumes, or smoke being exhausted into the atmosphere or public disposal systems.

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In advanced military electronics research, the ability to do the job isn't good enough. The job must be done reliably and on time.
Hallicrafters' QRC program was originated to provide not only the finest of engineering facilities and people, but the flexibility required for immediate, crash effort on critical electronics problems.
Hallicrafters has provided our military forces for the past six years with a Quick Reaction Capability that has played a major role in helping to win the battle against time.
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Radiation Source

The Atomic Energy Commission has contracted with the Atomics International Division of North American Aviation for a feasibility study on use of the sodium reactor coolant at the Hallam Nuclear Power Facility as a high-level radiation source for industrial processing.

The study will investigate the technical feasibility of using the radioactive sodium coolant for industrial radiation processing and of integrating such a radiation processing plant with the nuclear power facility being built at Hallam, Nebr. Included will be a preliminary design study for the radiation processing plant.

U. S.-Euratom Power Program

The Commission of the European Atomic Energy Community and the U. S. Atomic Energy Commission announced recently that five enterprises from Belgium, France, Germany, Italy, and the Netherlands have indicated their intention to submit proposals under the Euratom-U. S. Joint Nuclear Power Program. These proposals would be for the construction of power reactors to be completed by the end of 1963.

The letters of intention have been submitted in response to a U. S.-Euratom invitation to participate in a joint program having as its primary objective the construction within the Community of large-scale nuclear power plants with a total installed capacity of approximately one million kilowatts. The Agreement for Cooperation provides that the reactors should be in operation by December 31, 1963, with the possible exception that completion of two reactors may be deferred to December 31, 1965.

Test Irradiation Services

The Atomic Energy Commission has selected, as a basis for contract negotiations, the proposal of the Babcock & Wilcox Company to provide the Commission with test irradiation services in a 60,000-thermal-kilowatt test reactor the company would build in Lynchburg, Va.

The proposed reactor would be water-cooled and moderated. It would take two years to build and would be used to provide irradiation services for a 5-year period. The estimated cost to the Commis-

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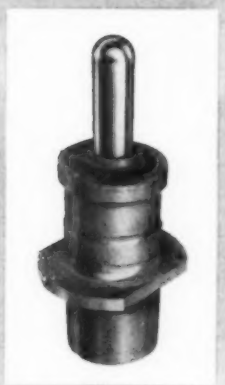

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sion would be about $15,000,000 over the contract period. The reactor will be used primarily to meet the Commission's test needs for neutrons in the low- and mid-flux ranges.

Neutron flux is the intensity of neutrons in a given area of a reactor to which components and materials may be subjected. This area provides environmental conditions similar to those in reactors for which the components and materials are intended.

To meet the Commission's expected low- and midflux requirements for irradiation services during the 2-year period of construction of the reactor at Lynchburg, as well as other requirements for irradiation services which may not be assigned to the Babcock & Wilcox reactor, the Commission will negotiate for space in other private test reactors which are existing or may be built.

Reactor Project Suspended

The AEC has suspended its research and development on a liquid-sodium-cooled, heavy-water-moderated nuclear power reactor concept. Work on the concept was started for the Commission in April 1957 by the Nuclear Development Corporation of America. The work was undertaken in connection with the proposal of the Chugach Electric Association of Anchorage, Alaska, for construction of a 10,000-electrical-kilowatt nuclear power reactor at Anchorage.

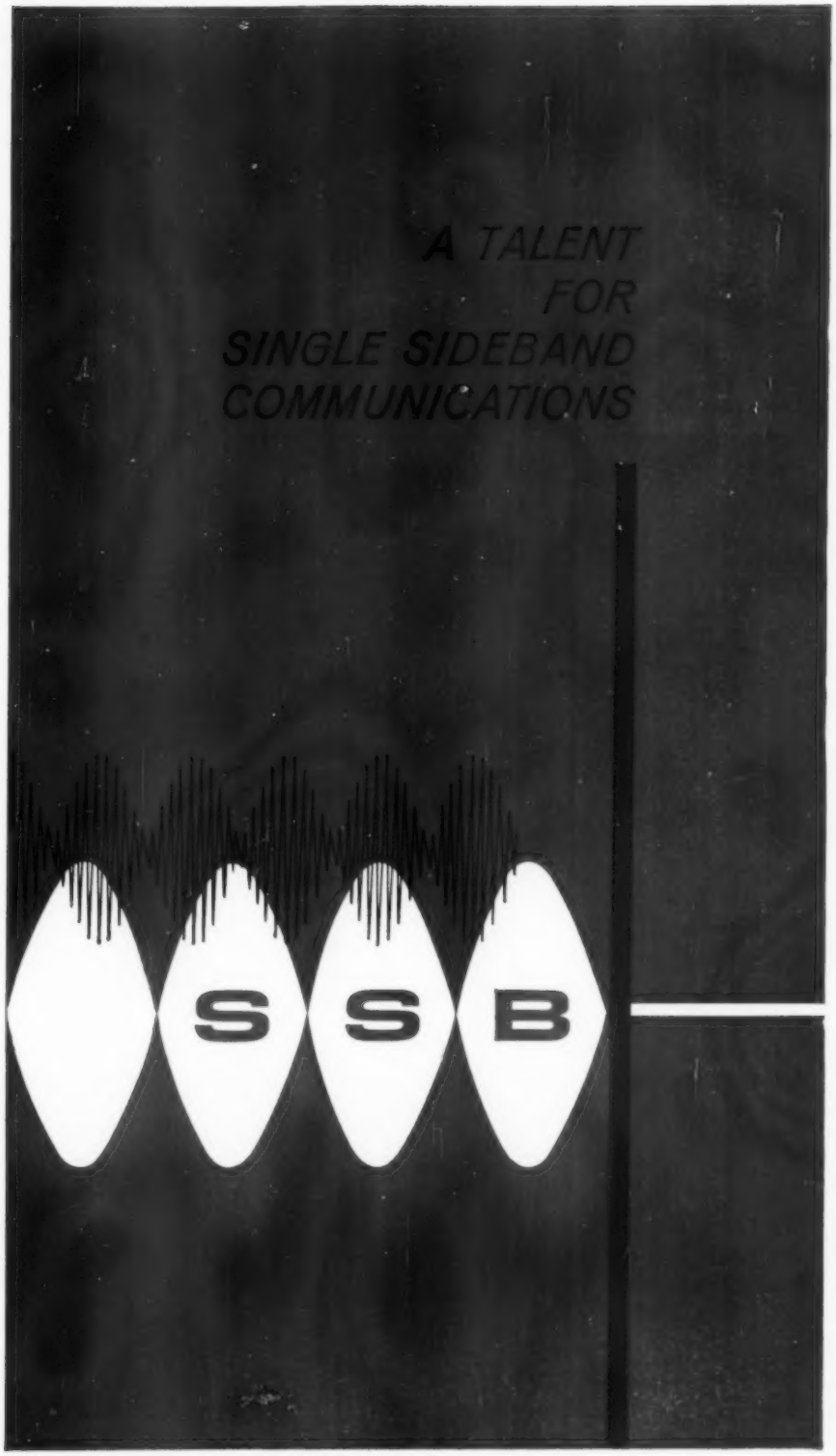
In the two years since the research and development project was started, it became increasingly apparent that, technically, it would not be sound to build at a remote non-Commission site a reactor that was not yet proved.

Philippine Research Reactor

The United States is providing $500,000 for a nuclear research reactor to be purchased by the Philippine Government. This culminates an offer by the United States in June 1955 to provide the Philippine Government with a research reactor with the understanding that the Philippines would bear the cost of maintaining and operating it. Subsequently, $500,000 was appropriated by the U. S. Congress for this purpose.

The reactor will be located in a nuclear center within the campus of the University of the Philippines, Quezon City.

The International General Electric Company, New York, N. Y., will build the reactor under a contract with the Philippine National Science Development Board. The one-megawatt, light water cooled and moderated reactor of the pool type, will use fuel elements consisting of plates containing uranium enriched to twenty per cent in uranium 235.



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AT THE
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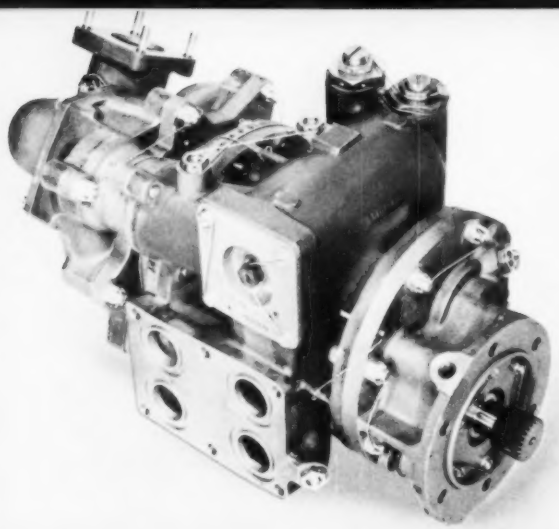
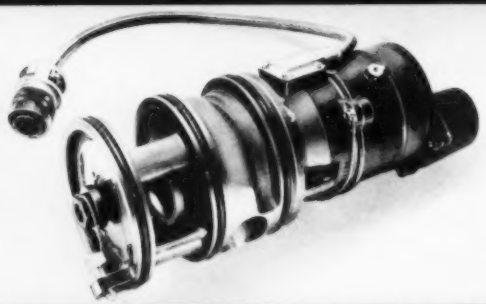
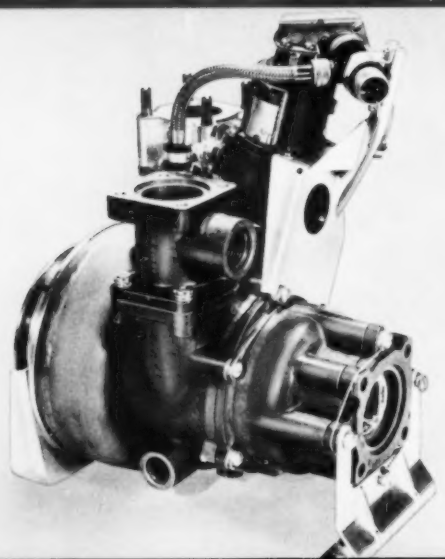
and production of fuel
systems and components



TAPCO designed and produced engine-driven combination main-and-afterburner fuel pump now providing thousands of hours of trouble-free service in several current models of production fighter aircraft.



Plug-in type electric motor driven submerged booster pump, designed and produced by TAPCO for a major American jet airliner, facilitates easy removal for routine inspection without draining fuel tanks.



This turbine-driven water injection thrust-augmentation pump and controls combines three TAPCO Group capabilities: the experience and facilities to design, produce, and test the pump, electronic controls and turbine entirely within the TAPCO organization.

FROM THE TAPCO GROUP...

Pumps, Controls, and Accessories to handle any fuel, any fuel situation

Over 1,100,000 pumps delivered... twenty years of experience that began in 1939... 10,000 people... 3,000,000 square feet of research and production area ... these are some of the reasons the TAPCO Group is the leading developer and manufacturer of all types of aircraft and missile pumps, controls, fuel valves, and turbine-driven pumps and accessories.

TAPCO pumps have been developed to meet severest conditions of altitude, rate of climb, pressure, attitude, G-factors, and fuel chemistry. TAPCO-designed models include vane- and gear-type main engine fuel pumps, fuel transfer and vapor separating booster pumps, thrust-augmentation pumps, turbo-pumps, combination main-and-afterburner pumps.

New TAPCO impeller designs, improved seals and internal passages give TAPCO pumps maximum efficiency and the ability to perform dependably under severest flight and temperature conditions, while pumping any of the approved liquid fuels and supplements. A feature of TAPCO booster pumps is high vapor-elimination capability, which eliminates vapor-lock in the fuel system.

Other fuel-system components and accessories developed in producing homogeneous, single-source TAPCO fuel systems include control valves, air turbine drives for pumps, quick-disconnect couplings, flow-equalizer valves, and in-flight refueling systems.

For your aircraft or missile contract, let us supply you with a *complete fuel system* designed, built, and fully service-tested by the leader and largest manufacturer of fuel pumps and systems... the TAPCO Group.

TRW

TAPCO GROUP

Thompson Ramo Wooldridge Inc.

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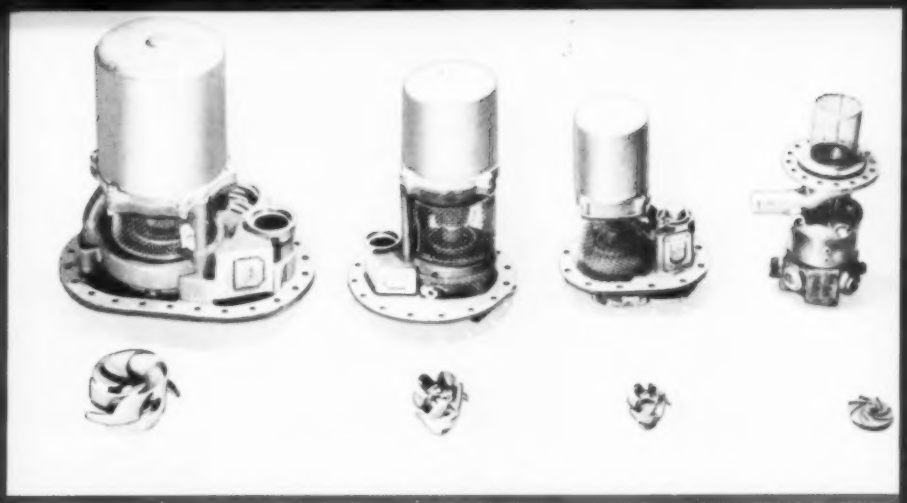
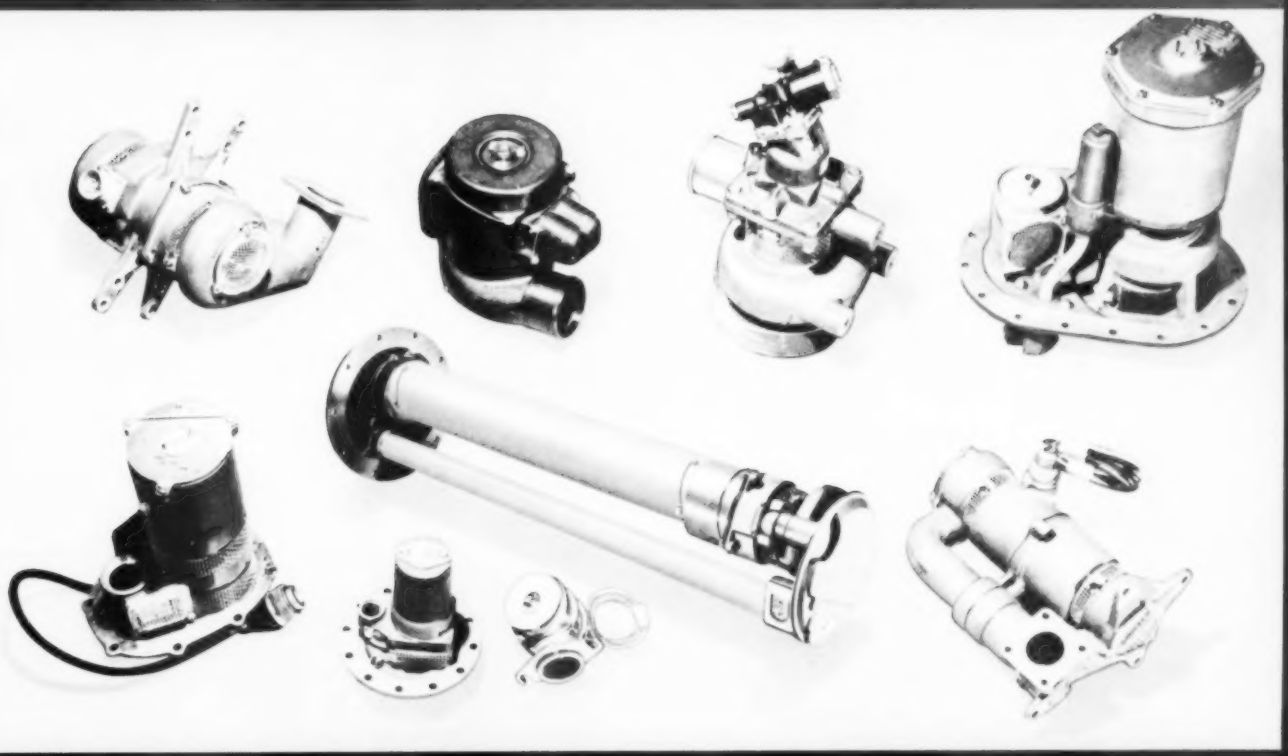
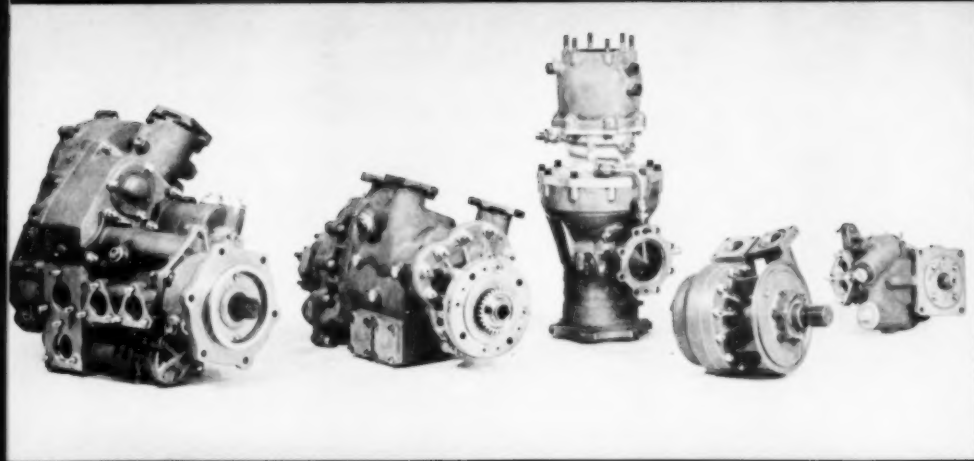
DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

Over 20 years of booster pump experience is illustrated by representative models in this and the center photo. Early World War II DC electric motor-driven model, at right, had a capacity of 3 gpm at altitudes to 35,000 feet. Later models, at left and below, can handle up to 250 gpm at 70,000 feet. The impellers shown indicate the results of TAPCO research to provide good vapor elimination and pumping ability as requirements increased.





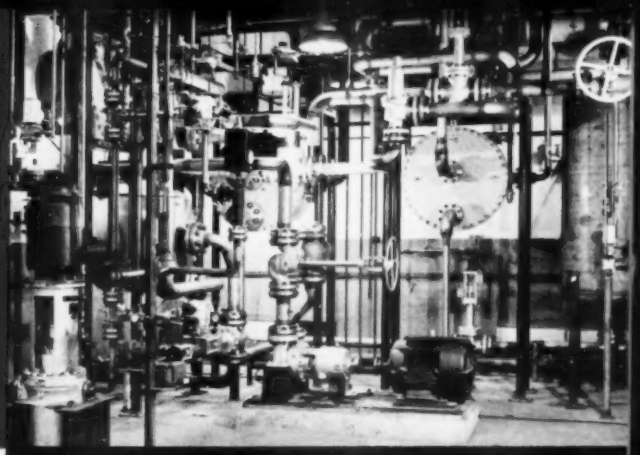
The broad variety of booster pumps now in production at TAPCO includes these AC electric and hydraulic motor-driven units for helicopters and small aircraft, as well as special designs for unusual negative G conditions for high performance fighter aircraft. Capacities range from 2 gpm to 250 gpm.



Engine-driven gear, centrifugal and regenerative-type fuel and water injection pumps for military and commercial aircraft are designed, produced and tested in the TAPCO Group's facilities. Capacities range from 2 gpm to 220 gpm, with discharge pressures as high as 1200 psi and suction specific speeds as high as 30,000 rpm.

IN THE TAPCO GROUP...

Complete research and test facilities... plus supporting services



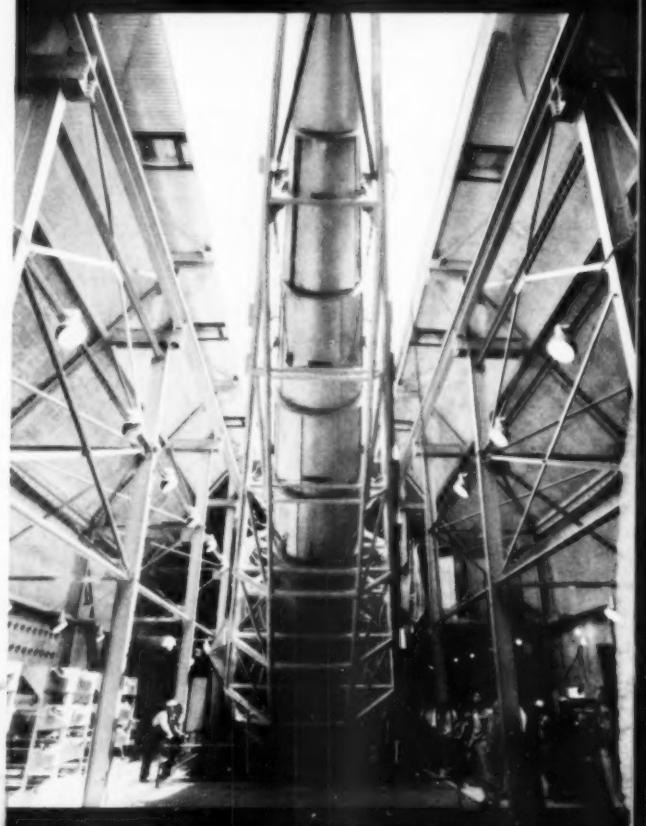
Hot-fuel test lab at TAPCO, shown only in part here, can test fuel pumps under ambient temperature conditions as high as 750° F, circulating up to 500 gpm of fuel at 550° F at 1500 psi. Pump-driver speeds up to 28,000 rpm are available. These conditions can be cycled for high Mach number flight schedules.

For over 20 years, the development of new fuel system principles and the design of pumps and components to utilize these principles have been a major area of investigation for the TAPCO Group research department. Just as the seemingly insurmountable problem of getting cargo aircraft over the Himalaya mountains was solved by TAPCO-pioneered booster pumps during World War II, TAPCO continues to pioneer the state of the art in fuel system development.

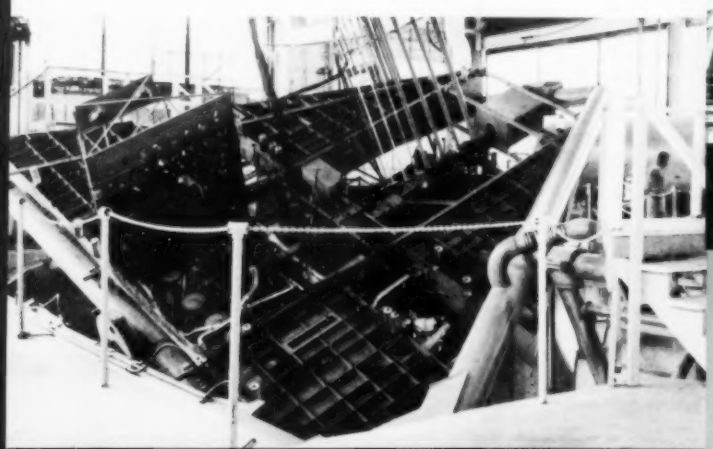
Today, more than 1000 experienced men and women using 7 TAPCO fuel labs are investigating and developing techniques to power tomorrow's flight vehicles of all types. They have worked with high energy fuels such as boron, slurries and monopropellant fuels such as ethylene oxide, UDMH and normal propylnitrate. Extensive work has been done with anhydrous hydrazine. Experience is being accumulated with the new fuels for advanced spacecraft, such as liquid hydrogen.

To assure proper support for fuel system and component contracts, a highly-skilled field service organization is maintained, and spare parts singly or in kits are available to meet your requirements.

Let us have a TAPCO Group sales engineer discuss *complete* fuel systems, pumps, controls, and valves with you soon.



Complete missile fuel system mockup at a TAPCO laboratory simulates missile flight conditions for pre-flight checkout of the fuel system.



High performance fighter aircraft fuel system simulated by this complete mockup at another TAPCO facility saved hundreds of expensive flight test hours.

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DESIGNERS AND MANUFACTURERS OF SYSTEMS, SUBSYSTEMS AND COMPONENTS FOR THE AIRCRAFT, MISSILE, ORDNANCE, ELECTRONIC, AND NUCLEAR INDUSTRIES

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Founded 1919

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LIEUT. GEN. BERNARD A. SCHRIEVER

Commander, Air Research and Development Command

Air Force Research

Dynamic leadership and vast scientific talent mark the program

IN its comparatively short existence, the Air Force's Air Research and Development Command has assumed an increasingly vital role in this country's defense.

The stated aim of this Command is to build for the qualitative superiority of matériel through research and with this research to develop new and improved devices, processes, and techniques. An integral part of the mechanics of this Command is the concept of the Air Force-Science-Industry Team which was formed to gain the full support of the entire Nation's scientific talent.

This team develops complete weapon and support systems based on the planned integration of such fields as guidance, power plants of more efficient and increased thrust, airframes, armament and firepower systems of greater accuracy.

ARDC operations extend into three major areas—research, development, and engineering services. The research program is concerned with basic and applied research as well as experimental vehicles and test instrumentation. Under the Air Force concept, the Command supports basic and applied research directly through contracts with industry in addition to colleges, universities, and nonprofit foundations.

THE Air Force concept of applied research is to explore knowledge, matériel, and techniques to obtain an experimentally demonstrated capability to satisfy an existing or anticipated operational requirement. This brand of research is not necessarily identifiable with an existing planned system, but may focus on an experimental model to prove functional adequacy.

Lieut. Gen. Bernard A. Schriever, Commander of the Air Force Air Research and Development Command, was graduated from Texas A. & M. with a bachelor of science degree in engineering in 1931, and in 1942 he received a master of science degree in aeronautical engineering from Stanford University.

A Reserve appointment in the Field Artillery upon graduation from college began General Schriever's military career, and in 1933 he was commissioned as a 2nd lieutenant in the Air Corps Reserve. With an interim position as a pilot with Northwest Airlines, General Schriever reentered the service to accept an appointment as 2nd lieutenant in the Regular Army.

In July 1942, General Schriever joined the 19th Bomb Group in the Southwest Pacific. While in that theater, he participated in the Bismarck Arch, Leyte, Luzon, Papua, North Solomon, South Philippine, and Ryukus campaigns, flying a total of sixty-three combat missions. He later assumed command of the Advanced Headquarters, Far East Air Service Command.

Assigned to Air Force Headquarters in 1946 as Chief of the Scientific Liaison Section, Deputy Chief of Staff, Matériel, General Schriever entered the National War College in 1949, and in 1950 he returned to Air Force Headquarters to become assistant for evaluation, Office of the Deputy Chief of Staff, Development.

In 1954, General Schriever filled the dual position of assistant to the Commander of the Air Research and Development Command and commander of the Air Force Ballistic Missile Division. As first commander of this division, General Schriever directed the development of an intercontinental ballistic missile. In April 1959, General Schriever was named Commander, Air Research and Development Command.

As Commander of the Air Research and Development Command, Lieut. Gen. Bernard A. Schriever has the responsibility for managing the widespread military-science-industry brainpower required to provide the Air Force with the military tools to do its job—weapons of superior quality, created and developed by engineering leadership.

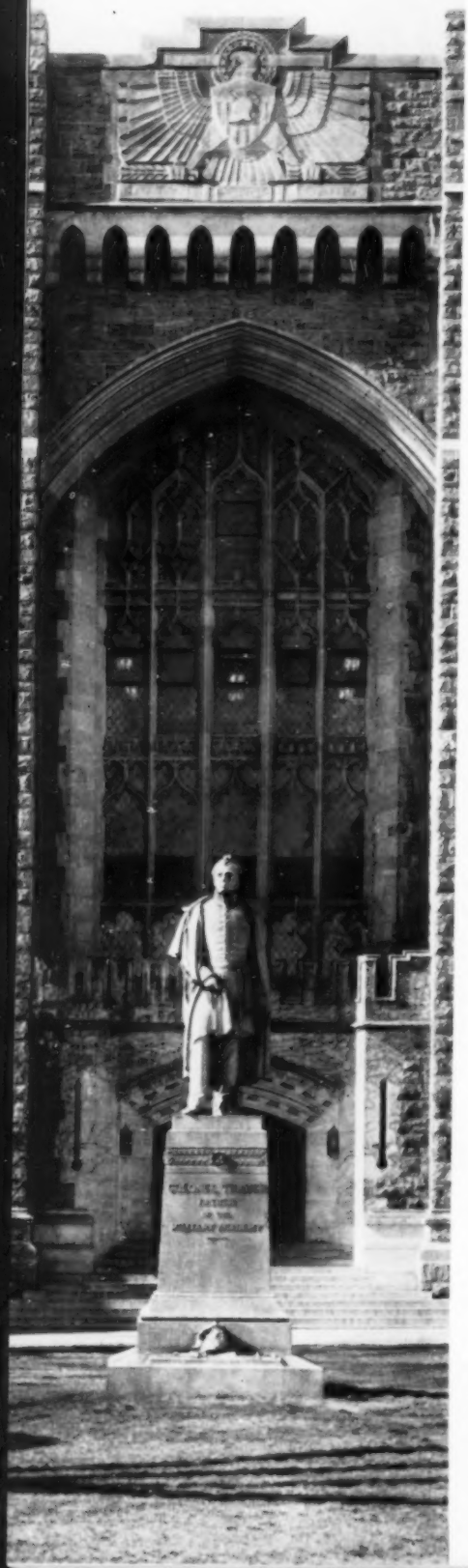
With twelve major centers scattered throughout the United States, each with its specific mission and unique facilities, the ARDC research and development program is made up of approximately 800 individual projects covering a wide spectrum of scientific activity.

THE management of this operation demands a rare blend of military and scientific knowledge coupled with engineering know-how and tempered by a thorough understanding of management and administrative principles. General Schriever abundantly fills these qualifications. As Commander of the Air Force Ballistic Missile Division, he was faced with the task of developing an effective intercontinental ballistic missile in the shortest possible time.

Within the space of five years, this Division has built and test-flown Atlas, Thor, and Titan missiles.

Test stands, check-out facilities, launchers, and masses of analytical equipment have been developed and put into use. Construction has begun on bases for operational Atlas and Titan missiles. Two ocean-spanning missile ranges have been implemented, and tracking stations have been placed in globally strategic areas.

The dynamic and brilliant leadership given by General Schriever in the Ballistic Missile Division will find its proper focus in the even broader aspects of the entire Air Force Research and Development Command.



Tempered by Fire

Brig. Gen. Sylvanus Thayer, "Father of the Military Academy," overcame many obstacles to assure trained officers for the Army

Maj. George Fielding Eliot

THE memory of Brevet Brig. Gen. Sylvanus Thayer, Corps of Engineers, is revered by all graduates of West Point, who know him as "the Father of the Military Academy." Each year, in an impressive ceremony at the foot of his statue, the Corps of Cadets pays its respects to the man who made West Point what it is today.

That Thayer took hold of a run-down, neglected, and almost moribund institution and, in sixteen years of intensive application (1817-1833), transformed the Academy into an efficient agency for turning raw plebes into competent second lieutenants would be a sufficient title to fame in this or any other country.

But in the process of doing that job, Thayer found himself compelled to do something else of vast value to the United States. He not only "fathered" West Point as we now know it; he was also the father of engineering and technological education in the United States, which before his time had no school of engineering or institute of technology.

Considering the overpowering need of the young, raw, energetic, but unschooled people of America for engineers to open the waterways of the West, control floods, build roads and bridges (and, later, railroads), draw maps and explore the wilderness, chart the coasts and harbors, and construct forts and breakwaters, the service which Sylvanus Thayer performed in planting the seeds and nurturing the growth of technological education can hardly be overestimated.

For fifty years after Thayer left the superintendency of West Point, the technical schools and colleges that began to appear in response to this growing demand were without exception indebted to Sylvanus Thayer and West Point in one way or another—either for instructors or methods of instruction, for new works on mathematics, science, and engineering, for translations of French and German works—or all of these together.

The military establishment of the United States today and the Science-Industry-Ordnance Team which supplies and supports it, owe an immense and never-ending debt to Sylvanus Thayer. So does the Nation as a whole, for he laid the intellectual foundation of our industrial prosperity.

BUT what restless, demanding spirit urged him on to accomplish all this? Not personal ambition, certainly—few great men in our history have been more self-effacing or less self-seeking. Thayer rarely considered his own feelings a suitable reason for putting pen to paper, but he did once write to his mother, "I have a duty to perform, and I intend to carry it out regardless of consequences personal to myself."

In the ultimate pursuit of that duty he did not hesitate to oppose his will to

that of the formidable Andrew Jackson when the latter became President and for a time included West Point in the scope of his famous political maxim, "To the victors belong the spoils." When Jackson seethed, and friends such as Generals Scott and Swift warned Thayer that his resistance to political favoritism was being viewed as a personal affront by the fiery-tempered President, Thayer quietly decided that the good of the Academy required his resignation as Superintendent.

Jackson was a soldier—he would see the error of what he was doing once the element of personal opposition was removed. So Thayer removed himself—confident that by that time his work was done.

It was not personal ambition that drove Sylvanus Thayer to seek the seeds of technological knowledge for two years in Europe and then to plant and tend them in the West Point garden, protecting the tender shoots with fierce devotion against the storms of politics, the blight of indifference, and the chill winds of senseless jealousy and criticism until their roots took hold and they could stand alone. The flame that burned in the heart and mind of Sylvanus Thayer was an altar-flame—a flame of dedication to a cause that he placed far above his own welfare.

THE cause he served was his country's safety. The fervor of his dedication was derived from the bitter experience of the War of 1812. This is not a statement that can be documented from the records. It rests on the logic of chronology.

From the time of Thayer's graduation from West Point in 1808 until the outbreak of war in 1812, he remained just a good, competent, run-of-the-mill lieutenant of Engineers who performed routine duties to the satisfaction of his superiors while he waited for the slow attrition of the Army Register to bring him promotion.

There had been no sign of any special ambition, much less of dedicated purpose about Lieutenant Thayer up to the time when, in June of 1812, word of the declaration of war against Great Britain reached Governors Island where he was acting as commissary of ordnance in addition to his engineering duties.

Something less than three years later, with the war ended, we find Brevet Maj. Sylvanus Thayer laying relentless siege to the halls of the mighty, demanding with a persistence that would not be denied that immediate steps be taken for the reform and renovation of the Military Academy—and with a definite plan as to how that should be brought about.

What had happened during those war years to turn the quiet-spoken young lieutenant into a crusader for military and educational reform?

As we seek today to find adequate motivations to draw the cream of our youth into the armed services and the scientific and engineering professions upon which our national security depends, the story of the dawn of dedication to that same cause of national security in the heart and mind of Sylvanus Thayer may not be without interest. In plain and simple terms, young Thayer responded to challenge.

The challenge grew out of his experiences in war and his habit of analyzing experience on a cause-and-effect basis. Perhaps his boyhood admiration for Napoleon Bonaparte had something to do with his application of analysis to military affairs—certainly he had for years been a careful student of the Napoleonic campaigns. He could hardly have expected the poorly trained, half-equipped, hastily expanded U. S. Army of 1812 to measure up to such standards—and yet the actuality must have been a terrible blow.

War as Thayer saw it in those years from 1812 to 1815 contained nothing of the glitter of victory or even the grim satisfaction of having made the enemy pay dearly for his gains. Shame and suffering, frustration and futility—opportunities thrown away, lives wasted, the very survival and independence of the Nation imperiled by incompetent leadership and faulty training—this was war as Thayer saw it, and when sheer good fortune and the war-weariness of the British people after Napoleon's abdication saved America from the worst consequence of military neglect, there was but one thought in Thayer's mind: "Never again!" The good New England metal that was in Sylvanus Thayer had passed through the crucible and had been forged into a tempered blade.

THE hammer blows of that forging might well have shattered metal of lesser quality. In the early days of the war, Thayer was ordered to the headquarters of the Northern Army at Plattsburg to serve as ordnance officer on the staff of Maj. Gen. Henry Dearborn, an elderly and hesitant relic of the Revolution.

There Thayer heard the news of Hull's shameful surrender of Detroit, and of the shambles on the Niagara River when a regular advance guard which had gained a brilliant initial success was overwhelmed by superior numbers because the militia of the main body refused to cross the river to its support—on the ground that they couldn't be required to leave the State of New York to invade foreign territory!

In the camp at Plattsburg he saw so-called Regular regiments dwindle away to mere skeleton units of two or three hundred men because recruits could not be obtained, patriotic fervor being chiefly directed to building up the ranks of the militia. He saw the few available graduates of the Military Academy being employed, like himself, on staff duty while competent regimental commanders such as Zebulon Montgomery Pike were left without a single experienced company officer.

His baptism of fire came in the late fall on the LaColle River. Dearborn, reenforced by militia units when it was clear that recruits would not be forthcoming for the Regular regiments, was ordered to advance against Montreal and redeem the disasters in the West.

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A book about Brig. Gen. Sylvanus Thayer and West Point, written by Major Eliot for teen-age readers, will be published this fall.

The Army marched out with high hopes and loud shouts of "On to Montreal." Pike's regiment drove in the enemy outposts—but then a militia regiment on his flank got lost in the woods, mistook Pike's men for the enemy and opened fire on them.

The British commander instantly took advantage of the confusion and attacked with a mere handful of men. The American advance units fled back across the river, the rest of the militia refused to cross the frontier, and General Dearborn, having sustained perhaps half a dozen casualties, turned round and marched back to Plattsburg where he went into winter quarters.

Thayer's next campaign, in the fall of 1813, was a dreary repetition of this experience. In the spring, Dearborn had been sent with part of the Army to Sackett's Harbor, under orders to attack the British naval base at Kingston —the key to the whole Western theater of war and to the naval command of Lake Ontario.

But Dearborn took counsel of his fears, hesitated, changed his mind three or four times, and finally embarked his troops on the lake and made an amphibious attack on York (Toronto) which produced a local success with no lasting result except that it cost the life of General Pike, the most promising general officer of the Army at that time.

THIS piece of imbecility and a subsequent defeat on the Niagara frontier cost Dearborn his command. He was relieved by the infamous Maj. Gen. James Wilkinson, who was ordered to start all over again at Sackett's Harbor and advance down the St. Lawrence with Montreal as his objective. All this weary spring and summer of 1813, Thayer (now a captain) stayed at Plattsburg sweating out the ordnance red tape and, we may presume, getting sick of the sight of arriving messengers who brought nothing but bad news.

To the command of the troops at Plattsburg was assigned Maj. Gen. Wade Hampton, another Revolutionary veteran chiefly distinguished for his implacable hatred of Wilkinson. So when, in the fall, he was ordered to advance northwestward and join Wilkinson's column in the advance on Montreal, he found plenty of excuses for wasting time.

At last he ran into opposition on the Chateaugay River, where he tried to outflank the enemy—to whom he was superior by perhaps five or six to one. His flanking force became bogged down in a cedar swamp, was fired on by a few Indians and Canadians, panicked and ran.

That was enough for Hampton, who was only too glad of an excuse to abandon the hated Wilkinson to his fate. Back to Plattsburg marched the army. Captain Thayer, who had had the doubtful pleasure of carrying the order to retreat to the only regiment—Izard's—which had accomplished anything at all, may have derived some melancholy satisfaction from noting that the enemy's bold attempt at pursuit was stopped by the smart artillery work of a fellow West Pointer, William McRee.

At Plattsburg, more bad news soon arrived—Wilkinson, only too happy in his turn to retreat and be able to lay the blame on Hampton, had also abandoned his invasion of Canada and fallen back across the border to go into winter quarters.

That wasn't the end of the bad news. In Europe, the battle of Leipzig foreshadowed the collapse of Napoleon's Empire. That would free British hands to deal with the Yankees. The prospects of the young Republic in 1814 were gloomy indeed. There was only one ray of light—the old incompetents were at last giving way to younger men who had been proved in battle—Jacob Brown, Winfield Scott, Ripley and Gaines and Macomb. Perhaps—just perhaps—there might now be a taste of victory, a proof that American valor, given proper training and leadership, was still battleworthy.

Captain Thayer besought the Chief of Engineers for orders to Brown's army on the Niagara frontier. McRee went there, but Thayer went to Norfolk to build seacoast forts, for the British fleet was in Chesapeake Bay. And there he stayed, while the blockade tightened, while Wellington's veterans gathered on the northern frontier, while British raiders burned the Capitol and the White House—until at last fever struck him down and his misery was dulled for a time by delirium.

WHEN he recovered, in February of 1815, he awoke to a brave new world. The British invasion in the North had been turned back by Commodore MacDonough's victory on Lake Champlain; in the South, Maj. Gen. Andrew Jackson had beaten off another invasion at New Orleans—chiefly because a British general, scornful of "colonials," had been fool enough to launch a frontal attack over open ground against intrenched riflemen and field guns.

Best of all, the war was over. The British Government, constrained by the

West Point cadets pass in review across the Plain at the USMA (Army photo).

temper of a people wearied of war during twenty-two years of struggle and sacrifice, had made peace with the United States on terms which, on the whole, yielded every major point demanded by the American negotiators. "The good Lord," said the cynics, "looks after fools, drunkards, and Americans."

TO the analytical mind of Sylvanus Thayer, accustomed to dealing with probabilities and the law of averages, there came the conviction that his country was never likely to be so lucky again. He arose from his sickbed a dedicated man—dedicated to the purpose of systematically creating for the United States Army a corps of professional officers, the product of scientific education and stern disciplinary training, who should in future be the bulwark of the Nation against the recurrence of war and the assurance of victory if war should come.

There were many kind friends to point out that he had set himself an impossible task. The difficulties, indeed, were great enough to have daunted any ordinary spirit. But Thayer overrode them one by one.

Virtually no textbooks on advanced mathematics, physics, chemistry, and the other essential sciences were available in the country—much less works of reference and books on the art of war. Very well; Thayer would go to France, buy the books he needed, and study the methods and techniques of the great French military-technical schools such as the École Polytechnique.

But that would take money, and the Treasury was empty. No matter. Thayer's inspired enthusiasm and persistence were so contagious that somehow the Acting Secretary of War, James Monroe, and Chief of Engineers Swift, managed to scrape together the needed funds.

Well and good, but what about the raw material of the new Corps of Cadets? For years the entrance examination at West Point had, of necessity, been geared to the average educational level of the available applicants—simple arithmetic plus the ability to read and write English. What will such lads do with the French textbooks?

Thayer's answer was ready: a 4-year course—the first year to be spent in acquiring basic mathematics, through plane trigonometry, and sufficient French to be able to understand the new texts; then three more years to use these tools.

An impossible work load, cried the skeptics. A challenge, retorted Thayer. There are young men in America who will rise to it—plenty of them. Some will fail, but enough will succeed.

"The country won't support such an institution—Congress won't go along with the annual expense," urged some doubters. "We've got to recover from the war."

"I know that," said Thayer. "But economic recovery means trade, and trade means opening up the West, and making a wilderness productive requires engineers. If the Military Academy provides the engineers the country needs, the country will support the Military Academy. That's plain Yankee horse sense. What's more, there's no other source of engineers available to say nothing of any other source of officers for the Army, which is going to be needed for many years to keep the Indians in hand even if we never have another foreign war."

So in the end, to the great good of the Nation, Sylvanus Thayer had his way. One man who knew what he wanted and was determined to get it prevailed over many doubts.

What Sylvanus Thayer did, he did not for himself but for his country. His inspiration was born of perceived necessity, of the bitter experiences of the battlefield, of the conviction that one day the Nation might perish unless enough of her young minds were trained and dedicated to her defense, unless the gates of the future were unlocked with the golden key of science so that in war and in peace the country might have the leaven of skilled leadership without which neither valor nor energy could preserve her.

AS these words are written, the nomination of Brevet Brig. Gen. Sylvanus Thayer, father of the Military Academy and of technological education in America, lies before the electors of the American Hall of Fame as a candidate for consideration at the quinquennial election in 1960. Few, indeed, have deserved this final honor more.

Majestic buildings rising from the famous Plain make the present-day Military Academy an inspiring sight (Army photo).

National Guard photo

The Air Reserve Forces

We need a return to the spirit of the National Defense Act of 1916

William V. Kennedy

FOR the first time in the peacetime history of the United States Air Force, a "reserve" unit has relieved the Regular service of a major air-defense responsibility.

The unit is the 199th Fighter-Interceptor Squadron of the Hawaii Air National Guard. The mission is the fighter air defense of Hawaii.

Stranger still is the fact that, as an Air Guard unit, the 199th was originally considered an "augmentation" force. Now, the Pacific Air Force lists Regular Air Force, Navy, and Marine Corps fighter aircraft in transit through Hawaii as "augmentation" forces.

This dramatic "up-grading" of the National Guard is by no means peculiar to Hawaii.

Although not a part of the Air Reserve Forces as such, Army National Guard Nike missile battalions are in the process of taking over from Regular Army crews at Nike sites throughout the United States. In addition, two Bomarc air-defense missile sites are to be operated by the Air National Guard on a test and evaluation basis.

There is a distinct possibility that Air National Guard crews will be able to man and operate Intercontinental Ballistic Missile installations more efficiently and more economically than Regular crews.

In the field of transport aviation, the Air Force Reserve, thanks to its reservoir of jet-experienced commercial pilots, at the moment possesses a better potential for operating jet transport aircraft than does the Military Air Transport Service of the Regular Air Force.

This new and encouraging trend in reserve-forces development stems from what is probably the outstanding example of Regular-National Guard-Reserve teamwork anywhere in our armed forces today.

In part, the team spirit stems from the traditional camaraderie of the air. In greater part it is the product of an agreement on roles and missions that has made the components of the Air Reserve Forces complementary rather than competitive.

The Air Reserve Forces consist of the Air Force Reserve and the Air

National Guard. The Air Force Reserve is a Federal military force administered directly from the Pentagon through the Continental Air Command at Mitchel Air Force Base, N. Y. It has its origins in the National Defense Act of 1916. This act established what was then known as the Organized Reserve Corps to train officers and men for whom spaces or adequate specialized training could not be provided by the National Guard.

The Air National Guard traces its origins, through the Army National Guard, to 1636 and, on Puerto Rico, to 1510. With the Army National Guard, the Air Guard forms the Organized Militia of the States, Territories, and the District of Columbia.

The present State status of the Guard is founded on the militia clauses of the Constitution. Under the Second Amendment, the National Guard is charged with safeguarding "the right of the people to keep and bear arms."

In peacetime, the governors are the commanders in chief of their respective National Guard forces. In time of national emergency, all or any part of the National Guard can be called or ordered into the active Federal service by the President. Under existing legislation and war plans, air and missile units of the Guard will go into combat instantly. The formal change of command need take no longer than thirty minutes to an hour.

DESPITE what is, in effect, complete unity of command, some Federal officers regard the Guard as "fifty-one little armies and air forces." Acting on this presumption, a group of Air Force officers and sympathetic civilians attempted, in 1949, to have the Air National Guard removed from State control and merged with the Federal Air Force Reserve.

Due largely to the efforts of the National Guard Association, a private organization maintained in Washington by the contributions of National Guard officers and men, this plan was thwarted. Upon the outbreak of the Korean war one year later, the Air Force found, somewhat to its surprise, that the Air National Guard was the only first-line reserve combat force it possessed.

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The reasons why this should be so are important to every American interested in the preservation of sound democratic institutions and in the operation of an efficient military establishment.

When the Air Reserve Forces were organized following World War II, there was little to choose between them in type of manpower. There was, however, a major difference in command structure.

The Air Force Reserve had to begin from scratch. The Air National Guard had behind it the experience and the efficient State headquarters staffs of the Army National Guard. Both the Army and the Air components were, and remain, under the adjutant general of each State.

Training and administration were standardized throughout by Air Force regulations administered through the National Guard Bureau, an agency of the Departments of the Army and the Air Force. Expert assistance was available from Regular Air Force instructors, now called "advisers," at State and unit level.

The Guard Bureau had enough power to ensure uniformity and high standards, and the States retained enough power to ensure that consideration was given to local needs and local conditions.

Last, and most important of all, Air Guardsmen were not merely part of an amorphous blue mass. They were *New Mexico, Wisconsin,* and *Georgia* Air Guardsmen. To fail was to disgrace their home State. To excel was to reflect credit upon it.

By 1949, the Air National Guard had emerged with the best aircraft, the best facilities, and the best performance record in the Air Reserve Forces program. The Air Force Reserve was striving mightily, but each time it seemed to be getting somewhere it was turned on its head by a reorganization directed from the Pentagon.

The Air National Guard had its reorganizations, too. But between the Guard and the turmoil of the Air Force Reserve stood the power of the State and Territorial governors.

The Guard accepted with alacrity any conversion to new equipment, or any reorganization that tended to improve combat efficiency. But it refused to submit to the seemingly whimsical redesignations, transfers, changes in mission, and reclassifications that were playing hob with the Air Force Reserve.

THIS situation resulted in what has become the most fundamental change to take place in the character of the Federal and State reserve systems: The men who were willing to devote the time and the effort required to build an effective reserve combat force began to shift to or to seek out the Air National Guard. Those who were interested, but who could not devote the necessary time, tended to remain in the Air Force Reserve.

To all these factors was added the catalyst of the National Guard's then-unique full-time National Guard Bureau employee program.

Prior to World War II, a few Cavalry and wagon sergeants, mechanics, warehousemen, and headquarters personnel, mostly State-paid, made up the only full-time force the Guard possessed. From their experience in World War II, Guardsmen brought back the conviction that, to carry out its mission in modern warfare, the National Guard needed a full-time staff down to and including company level.

This need was met by appropriating funds to the National Guard Bureau. The Bureau, in turn, hired the necessary personnel through the active-duty United States Property and Fiscal Officer in each State charged with responsibility for Federal funds and equipment.

All "NGB employees" are required to be members of the National Guard

unit with which they are employed, and to work in the same military job in which they are assigned in the unit. They wear the uniform during the duty day and are required to enter active service with their unit on the call or order of the Governor or the President.

Concurrently with this program, the States expanded their military payrolls. Additional State funds also went into improved administrative, hangar, and other flight-line facilities.

Despite this extensive support, the Air Guard would never have gotten off the ground had not some basic personal decisions been made by part-time Guardsmen.

It became obvious early in the development of the Air Guard that the man tied to a strict 8-hour day and 5-day week could not handle the work load required in the key command and staff positions. Teachers, the sons of merchants and manufacturers who were being brought into the family business, and professional men were among the only ones who could shoulder the load.

Even these faced the fact that if they devoted the time required, their family life would be severely restricted. Further, as long as they remained in the Guard, they would not have the time to develop their businesses and incomes to their full potential.

In many hundreds of instances, however, the decision was made in favor of the Guard.

UNDERSTANDABLY, the 1949 attempt to destroy the identity of the Air National Guard was opposed with great vigor and great bitterness. To the credit of the Air Force, once it encountered this stone wall it did not waste time butting its head against it.

The fiscal year 1950 Air Reserve Forces program was launched with a far more realistic regard for what was possible than had been apparent in the earlier programs, and when the Korean war broke out, the first important steps had been taken toward building the present team concept.

Twenty-two out of a total of twenty-seven Air National Guard wings were ordered into active Federal service, beginning in October 1950. Several served in Europe and the Far East. Five Air Guard pilots became aces in aerial combat against the Communist air forces.

While in 1950 the Air Guard was just starting to hit its stride, the Air Force Reserve had been bled white of appropriations by its parent service. Fifteen of the twenty-five Air Force Reserve wings were cannibalized to provide individual "fillers." Only ten entered active service intact. The major contribution of the Air Force Reserve was in the form of 80,000 individual Reservists from its nonunit replacement pool.

With the return of the Air Guard wings to State control beginning in 1953 and the reorganization of the Air Force Reserve, some of the old tensions once more became apparent. Air Reserve fighter-bomber and tactical reconnaissance wings were activated, sometimes on the same base as Air Guard units of the same mission.

The result was competition for men and equipment but with no better over-all results for the Air Force Reserve than had been achieved prior to Korea. Indeed, the results were mainly the harassment and further embitterment of the Guardsmen.

In November 1956, Gen. Nathan F. Twining, then Chief of Staff of the Air Force, directed a committee of general officers to examine the entire Air Reserve Forces structure and to determine how it could be improved. The key element of General Twining's directive was "to determine those functions which can be accomplished . . . by the Reserve Forces."

On September 26, 1957, the Air Force announced that henceforth the Air National Guard would operate twenty-four fighter-bomber, fighter-interceptor, light bombardment, and tactical reconnaissance wings. The Air Force Reserve would operate fifteen troop carrier wings and provide its traditional pool of individual Air Force Reservists for rapid mobilization.

Exactly 200 years before, Britain's General Braddock had acknowledged with his dying breath that the American militia was worth its salt. In 1957, for the first time in those two centuries, the Air National Guard had won the same admission from a component of the American Regular service.

The decision, with its assignment of clearly defined, complementary areas to the two reserve components, released a tremendous amount of energy. No longer forced to attempt a job the Air Guard was already doing, and doing well, the Air Force Reserve was able to concentrate on the job best suited to its capabilities.

IN the two years since, the Air Force Reserve wings have reached a point where they can perform, day in and day out, a substantial portion of the Air Force's troop and cargo carrier mission.

Under what is known as "Operation Swiftlift," the Air Force Reserve maintains 45 of its 713 C-119 and C-123 transport aircraft on an alert status, with crews ready to report to the flight line on short notice. As requests for priority air-cargo shipments are received from the Air Matériel Command, the crews are called in, the mission flown, and the aircraft returned to home base —all at little or no expense to the Air Force beyond what would normally have been spent on drill pay and aircraft operation.

In nonflying Air Reserve centers throughout the country the Air Force Reserve is training 115,732 "mobilization assignees"—officers and airmen with critical skills for the rapid reenforcement of the Air Force in the event of war.

These men and women already have their orders in their pockets. They will report directly to their assigned tasks in the event of war.

An additional 754 Air Reservists have mobilization assignments with units of the Air National Guard.

With the recent adoption of the Air Guard's civilian employee program, the Air Force Reserve has been able to effect a major saving in support funds and, at the same time, release for other duties Regular Air Force men who previously filled these positions.

The Air National Guard is at present

flying 2,000 jet aircraft, including F-100's, F-89's, F-94's, F-86D's and L's, F-84F's, RF-84F's, RB-57's and T-33's. It has a total of 71,000 officers and men, of whom 13,500 are full-time air technicians. Twenty-two of its squadrons maintain runway alert forces of armed and ready jet aircraft.

These are manned and supported by both full-time air technicians and part-time Guardsmen called to active duty for 90-day periods. Seven of these squadrons have a night and all-weather capability and are, in consequence, on duty twenty-four hours a day, the year round.

By apportioning the full-time staffs so as to cover every possible flying hour, most Air Guard bases operate on a 7-day-a-week schedule.

In the nonflying support unit area, the Air Guard operates fifty-six electronics, weather, communications, and general support units, plus twelve Air Force bands. Four aircraft-control and warning squadrons, including two in Hawaii, operate on a 24-hour basis.

If the proof of the present arrangement is in the flying, then Exercise Dark Cloud Pine Cone II, conducted from May 20th to June 9th of this year, should be proof enough.

Pine Cone II was a joint Army-Air Force maneuver designed, in part, to test the ability of Regular, Air Guard, and Reserve units to operate together.

DURING the course of the exercise, 70 Air Guard aircraft flew 1,500 hours in support of ground operations and troop drops, accomplishing 80 per cent of their planned missions. The remaining 20 per cent were scratched due to bad weather. A total of 131 Air Force Reserve aircraft carried out parachute drops of 2,908 Army paratroopers and 1,792,094 pounds of equipment in addition to air-landing 483 paratroopers and 324,410 pounds of equipment.

According to a spokesman for Maj. Gen. Richard A. Grussendorf, Assistant Chief of Staff of the Air Force for Reserve Forces, "Pine Cone II demonstrated that the Air Force Reserve was dependent on the Air National Guard for the establishment and maintenance of air superiority, while the Air Guard was dependent on the Air Force Reserve for resupply. The maneuver elements of the two components meshed together beautifully, providing a single, highly effective, interdependent force."

As with the development of Hawaii's 199th Fighter Squadron as a truly "ready" force, the efficiency demonstrated in Pine Cone II is much more than an isolated development.

Experiments are under way to test the ability of the Air Force Reserve to airlift ground elements of Air National Guard units to and from summer field training sites. In 1958, the experiment

was carried out successfully on a squadron basis. This year it is to be carried out on a wing basis.

The development of this mutual support on a nationwide scale will more than double the overall readiness of both components by providing a proven capability to operate anywhere in the world.

Last year, the annual worldwide Air Force rocketry meet was won by a team made up of a Regular Air Force adviser, three Air Guardsmen, and an Air Guard maintenance and support crew, all drawn from the 125th Fighter Group of Florida.

The future of both components of the Air Reserve Forces is bright.

The Air Guard had been apprehensive lest, with the introduction of air-defense missiles, it wind up as "tail-end Charlie" of the fighter-interceptor program. This danger disappeared with an announcement by the Air Force that two Bomarc missile sites would be turned over to the Air National Guard on a "pilot" basis "after the Air Force has gained sufficient operational Bomarc experience to evaluate the requirements of the air-defense system."

The construction of intercontinental ballistic missile bases, mostly in isolated locations, will create a major morale problem if Regular crews are assigned to man them. This problem already is a familiar one at isolated Strategic Air Command and Air Defense Command bases.

Its solution, by means of extensive recreational and housing facilities, has cost hundreds of millions of dollars. By turning over the new bases to locally recruited Air National Guard crews, both the morale problem and its expensive solution could be avoided.

THE next logical step for the Air Force Reserve is into the jet field. Thanks to its close working relationship with the civil air fleet and the considerable number of civil air fleet jet pilots already serving in its units, the Air Force Reserve has the means and the know-how to enter the jet field at any time.

"There are a few Reservists who would like to regain some of the combat-type missions and aircraft," an Air Reserve spokesman stated. "By and large, however, most Air Reservists seem well pleased with the present unit structure and mission. They do, however, regard a recent resolution of the National Guard Association requesting long-range transport aircraft as unreasonable, considering the mission and needs of the Guard, and as at least a minor threat to the teamwork and equilibrium that is developing."

Any such disturbance of the existing harmony would, indeed, be unfortunate. However, in the theory that what happened yesterday could happen tomorrow, and in light of nuclear-age demands for a decentralized command structure, potent arguments can be advanced for the transfer of the fifteen Air Force Reserve wings into the Air National Guard. Thanks to the groundwork already accomplished, the transfer could be made without a single important change in personnel, designation, or location.

The assignment of all Reserve units to the National Guard and of all individual replacement pools to the Federal Reserve forces would be a return to the spirit of the National Defense Act of 1916. Departures from this philosophy have brought little else but trouble.

The Air Force appears to have thought its way through to at least a temporary solution of its reserve forces problems, a solution based on complementary rather than competitive reserve components.

The Army National Guard looks on with envy.

Naval Ordnance Heritage

Over many years the Navy Bureau of Ordnance traditionally has guided the development of important sea and air weapons, centralized their administrative control, and sought the funds for their completion

Rear Adm. Miles H. Hubbard

THE Navy's Bureaus of Ordnance and Aeronautics are merging to form the Bureau of Naval Weapons. When the merger action is completed during the present fiscal year, the Bureau of Ordnance will bring to the new organization a heritage based upon many years devoted to supplying the U. S. Fleet with the best possible weapons. It is one of the oldest and most experienced producing agencies of the military services and has evolved some very effective management philosophies.

The Bureau of Ordnance has been the acknowledged leader in the use of scientific organizations as a part of the development team, especially in the use of nonprofit groups such as our universities. The Bureau also has developed some very effective laboratories of its own, using a combination of military and civil-service personnel in a manner designed to best exploit the talents of both.

The evolution of these present practices has an interesting history and stems directly from experience. Prior to World War II, the design and development of naval weapons were accomplished almost entirely within the Ordnance establishment. Production was also to some extent accomplished "in house," but a large portion was performed by private industry, and many advances in the state of the art came from this source.

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At that time an antiaircraft fire-control director was considered to be a very complex equipment, and so it was when compared with most other items of ordnance then current. That same director would appear the acme of simplicity when compared with a missile as relatively simple as today's service-proven Terrier.

This increase in complexity has been the predominant feature of the last decade of weaponry. It has led to the emphasis on weapons systems as presently employed by all the services and also has caused changes in management techniques necessary to produce modern weapons.

Before examining the resulting procedures evolved by the Bureau of Ordnance, it would be helpful to examine the question of "weapons systems." Like many other popular expressions, it has had some indiscriminate usage—such as a cloak of learning to conceal ignorance and as a compelling phrase used by salesmen. The best definition that I have seen was advanced by Dr. R. E. Gibson of the Applied Physics Laboratory of the Johns Hopkins University in an address at the Industrial College of the Armed Forces in 1959:

"We may define a system as an *integrated assembly of interacting elements designed to carry out cooperatively certain predetermined functions.* The definition is an inclusive one: it covers such simple systems as radio or television receivers; it covers more complicated fire-control systems; it covers industrial complexes such as a telephone system or an automatic factory. It also covers a warship or the men and weapons of an Army division; it covers organisms such as animal or human bodies; it covers organized societies.

"It places emphasis on the links which connect the elements—links through which the elements interact. Indeed, one of the important connotations of the term 'system' is that it raises the importance of the links and interactions to the level of the elements themselves."

IT can be seen that weapons systems are not new—the importance of the system is the big change that has resulted from the enormous increase in capabilities of its elements. There is a vast difference in the problems of hitting a 150-knot airplane flying at 10,000 feet and one flying at a speed of 600 knots at 40,000 feet!

The Navy Bureau of Ordnance was one of the prime movers just before and during the early part of World War II in mustering the scientific community into the weapons field. The problems even then had outgrown our in-house capabilities, and new ap-

proaches were needed in many areas. Industry was not the answer because its effort was needed for producing current weapons. Industry also was much better keyed to production than to research in those days.

There was a large source of scientific talent available in our universities and laboratories, and it was to this group that we turned. With the advent of the Office of Scientific Research and Development it became a simple matter to get a group working on one of the Bureau's most pressing problems—the development of a fuze to explode a projectile when within the damage range of the explosive charge without actually hitting the target.

This was the "VT" or proximity fuze and was assigned as a Section T project under the Office of Scientific Research and Development (OSRD) to the Applied Physics Laboratory of the Johns Hopkins University. This group, led by such prominent scientists as Drs. Tuve and Hafstad and assisted by "Deke" Parsons, later Rear Admiral Parsons (now deceased), a scientific naval officer with a firm grasp of reality, did an outstanding job.

ADMIRAL Parsons set the pattern that still holds for the military contribution to this type of effort—he supplied the military knowledge—the problem—and kept the effort pointed in the right direction. This was no small job, for the pure scientist will tend to follow an interesting development he may come across regardless of its relation to the problem. He also must be advised regarding the special conditions of environment that may be encountered. Admiral Parsons made such an impression that he later was moved to the atomic bomb project, and his record there is well known.

Thus the concept of a military-civilian scientific team was born. When staffed with qualified people, a quick and mutual respect for their complementary roles ensued, and the vast majority of our important developments since the inception of this system have come from such teams.

Guidance, centralized administrative control, and battling for funds have been the functions of the Bureau in these projects. It has proved to be effective primarily because (1) adequate technically qualified people have been available, (2) experience has been accumulated, (3) undivided loyalty is available for the Government's interests, and (4) military supervision has been sufficient to supply information on operating problems and conditions to be met.

The extent of the Bureau's operations under this concept is varied by circumstances. First, we have our own laboratories such as the Naval Ordnance Test Station at China Lake, Calif., and the Naval Ordnance Laboratories at White Oak, Md., and Corona, Calif. These stations are completely Government-owned and -operated, using civil-service and military personnel. Each is jointly headed by a military officer—its commander—and a scientific technical director. They are not production activities although they do some prototype work as well as model manufacture.

In general, their designs are product-engineered by a production activity, but they can be and are used for technical direction of manufacturing activities. Examples of their products are Mighty Mouse, Sidewinder, Hotpoint, Lulu, and many other good weapons.

Next, we have the university-operated laboratories such as the Applied Physics Laboratory of Johns Hopkins in Howard County, Md.; the laboratory of the University of Washington in Seattle; and the Ordnance Research Laboratory at Penn State. APL/JHU is the largest and oldest activity and is the original proximity-fuze organization.

When that project was successfully completed, the group, then at Silver Spring, Md., was given a project to develop a guided missile for antiaircraft purposes. This project was designated as "Bumblebee" and continued as a Section T activity until OSRD activities were terminated after the war. The Bureau of Ordnance then made a contract that is still in existence for continuation of this effort. The results were the Terrier missile which was first deployed in January 1956; the Talos which became operational in 1958; and the Tartar which will become operational soon.

In addition to developing these missiles, APL/JHU exercises technical direction of their production on behalf of the Bureau, assists in quality-control measures, such as surveillance, and recommends improvements. A resident inspector of ordnance performs the necessary liaison functions, and there is a close relationship between the Research Division of the Bureau and the laboratory.

The efforts of the other university-operated laboratories are devoted to the field of underwater ordnance, although the University of Washington effort was originally in the field of cosmic rays. All have produced timely and worth-while results which probably would not otherwise have been obtained. Our own laboratories plus these nonprofit institutions have given the Bureau stable, scientific talent of constantly growing experience that is completely responsive to its ever-changing needs.

THERE are many activities engaged in specific problems using both profit and nonprofit management. The bulk of the research and development effort is channeled through or supervised by the major activities mentioned.

It already has been noted that the research and development people do not engage in production; in fact, they do not normally do production or product engineering. The Bureau of Ordnance does have some "in-house" production facilities and tries to keep about twenty per cent of its work in these Government-owned activities. The remaining eighty per cent is contracted for with private industry.

Here, too, our system is based on many years of experience under varying economic conditions. For instance, it has been found that in times of active commercial markets, such as the period immediately after World War II, industry in general is more interested in commercial products with their higher profits. If the commercial market falls off, it is anxious to fill in the gap with Government business.

The Bureau has a complex of manufacturing activities, much fewer than at the close of World War II, but sufficient to protect its interests. They serve primarily as a source of sure availability and as a control to ensure against excessive costs resulting from monopolies. These plants employ civil-service labor and their payrolls contribute just as much or more to the communities as would be the case of a profit-making supplier.

Since such facilities are the core of the mobilization structure, their use keeps their people abreast of new manufacturing techniques and skills, as well as helping to defray the cost of their maintenance. If there comes a long period of international peace, such as occurred after World War I, these establishments will undoubtedly become almost the sole source of munitions manufacturing know-how just as they were in 1940. It is of interest to note that both Army and Navy Ordnance organizations follow this philosophy.

THE last of the major functions in the production of weapons in the Bureau of Ordnance concept is quality control. Quality control (QC) is known to most business people as a form of inspection, which is a small part of its mission.

In its broadest aspect it is a management tool which permits an independent assessment of a given weapon system from inception throughout its lifetime, based upon the stated desired qualities of the weapon. It is an engineering function, based upon science, proved by statistical data, and less subject to human errors than are most management tools.

By "looking over the shoulder" of the designer, QC knows what the weapon is designed to do—its limitations as well as its possibilities. Where previously proven components have been incorporated in the design, the sources of trouble are narrowed to the areas of unknown reliability. Thus it is possible to establish "probability of success" for each part of the item.

The proper use of statistics can then increase quality output of the manufacturing process. So QC takes the data evolved and uses them at the manufacturing plant as a means of inspection. The producer is given his tolerances and the degree to which his machines and processes may deviate from them. If previous agreement on the method of measuring such deviations has been reached, there can be no argument on the acceptance or rejection of the product.

In any complex mechanism the ravages of time cannot always be predicted. Conditions vary as do the reactions of combinations of materials. This introduces the necessity for surveillance or the study of product behavior during its lifetime. Here, too, scientific and mathematical processes are used to record and evaluate what happens under service conditions.

For example, how long will the battery in a fuze last if stored under various conditions? What part of a given mechanism breaks down first and why does it? The statistics maintained and studied will yield the answers.

Eventually there is the service test of our product. Since we are talking of a military weapon, we are after a one hundred per cent reliability when used in combat. If we were studying a vehicle, we would be interested in long life with minimum maintenance. QC now becomes the "customer's man." What was the final performance? What was desired that wasn't there? What would make the customer happier?

As a result of tests and study of statistical records of performance, QC can give the design engineer more information for incorporation in new designs. A better "mousetrap" should result.

The Bureau of Ordnance has a number of strategically located quality-evaluation laboratories manned by scientific and technical personnel to perform the tests, inspections, and evaluation functions required for this purpose. Their efforts are coordinated and information exchanged through a small control group in the Bureau proper. Each laboratory is located at an Ordnance station.

Thus far we have not discussed economy. The Bureau of Ordnance has been in the forefront of the move to reduce weapons costs. We are greatly assisted in the constant effort to do so by having available the high-caliber, dedicated civilian part of our team. Since our major activities are all under the technical direction of nonprofit groups, we have a management team that owes loyalty only to the United States Government and is completely free of stockholders' demands.

For example, at APL/JHU where technical direction of the T series of missiles is vested, every decision is made by a group of people who can only benefit by excellence of performance and minimum cost. Their individual professional reputations depend on the continued technical success of their designs; they do not share in the manufacturing profits but, as taxpayers, do share in the over-all cost.

THE same conditions obtain in our Government-owned and -operated stations such as the naval ordnance laboratories. Within the Bureau proper, all contracting is done by a separate group, operating under various governmental controls and regulations designed to ensure good business practices.

It is significant to emphasize that the military has not relinquished control in this system used by the Bureau of Ordnance. The determination of requirements, the assurance of effective design and production, and the establishment and maintenance of combat readiness are responsibilities which cannot be contracted or relinquished in any manner.

While it is pertinent to point out that some or several of the functions associated with design and production may be delegated to other activities, the responsibility *per se* is not and cannot be relinquished by the military. The Chief of the Bureau of Ordnance must and does manage the entire ordnance effort of the Navy.

Like any organization, the Bureau must have good people in the right places, good communications between them, and a concerted desire to do a good job. The *esprit* that is so necessary to success is there now; without it, no organization can function.

Soviet Helicopters

Above, the Horse, Hook, Hound, and Hare

Theodore George and Garrett Underhill

WITH interest focused on such amazing developments as satellites and long-range rockets, it is not surprising that little note has been taken of a less spectacular area of technology on which the Soviets nevertheless have put great emphasis—the helicopter, in its common or garden form.

Naturally, views on the subject of Soviet scientific-technical effort vary, but the evidence is conclusive that, since 1949, the helicopter has come to attain No. 2 priority in Soviet aviation. Thus, remarkable as it may seem, during the last few years the Soviets have ranked helicopters second only to air defense and ahead of manned bombers.

As a fully rounded research, development, and production program, the Red rotary-wing effort indisputably ranks ahead of the current drive to produce turbine transports. The latter to date are in the main hasty adaptations of extant jet and turboprop bombers. They remain very military as to power plants, cockpits, electronics, landing gear, and in some cases even airframes.

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As a result, the Soviet turbine transports are not yet very successful, nor are they yet competitive commercially with Western aircraft designed from the start to meet transport requirements.

Soviet helicopters, in contrast, are products of a thorough and careful research and development program dating back over thirty years. This effort has evolved helicopters as entities in themselves and not as by-products of some other line of scientific-engineering work.

The effort has been based on a long-term evolution of the necessary scientific aerodynamic theory and proven engineering practice. It has (according to classic Russian custom) taken into account with meticulous scholarship the state of the pertinent arts in the West.

Some idea of the Soviets' appreciation of helicopter potentials, and of their approach to technical progress in general, is furnished by the fact that, while serious research and experimentation have been carried on since 1927, the state of the rotary-wing art and of the Soviet economy was not deemed to have produced a practical helicopter until 1949.

(Imagine a government willing to wait patiently for over 20 years, before finding it feasible to design and produce

The Yak-24 Horse, above, resembles the Piasecki H-16 project now abandoned; below, the Mi-1 Hare, produced in large numbers and used in many roles.

hardware to meet operational requirements!)

In a manner typically Soviet, once having been established on a firm base of practical engineering, the Soviet helicopter program blossomed rapidly. Since 1949 four principal types have been produced in significant numbers. Initially put to extensive military use, lately they have been applied to a widening variety of civilian services.

Meanwhile there has been developed a giant turbine-powered helicopter, certainly the largest, and possibly the most advanced, in the world today. In addition, three of the principal types have been subjected to developmental improvement. In at least two cases this has resulted in major changes in performance and capability.

In point of fact, serious scientific Russian interest in vertical-lift aircraft goes back over 200 years, and the list of Russian aeronautical experts includes Lomonosov, Zhukovski, Yurev, Sikorsky, Kamov, Cheremukhin, and Bratukhin.

It is important to realize that a mere listing of names of active pioneers and their projects by no means can be regarded as a sound index of Russian or Soviet technical capability. In the past decades, while Russian and Soviet serious scientific interest and technological pioneering compared most favorably to those of the West, there was lacking anything like the basic national technical capability then available in America, France, England, and Germany.

BEFORE World War I, for instance, Russian creative engineering was at least the equal of any in the world. However, suitable engines just didn't exist in Russia, and in addition the engineering and industrial base to produce to native or foreign designs was grievously deficient. While Russia was a significant industrial power prior to the impact of the industrial revolution, from at least 1800 the West, with its mushrooming industries, left Russia further and further behind.

Only with the initiation of the first of the Communist Five-Year Plans in 1927 did there begin a ruthless effort to duplicate, on a government-backed basis, the continuous industrial growth

which had come about of itself in the West.

Moreover, even after the Five-Year Plans got Soviet industry well advanced, there was lacking the reserve industrial potential generally latent in the West and available to develop capacity for new product production.

The extreme need in World War II for production of basic items caused helicopter work to be dropped in Soviet Russia. This was at the very time it really got under way in America. Sikorsky, by then operating in Stratford, Conn., got his VS-300 single-rotor helicopter into the air in 1939.

In 1941, the same year the Russian Omega flew, Sikorsky was able to set an endurance record with a modified version. Later on that year a further modification led at once to the prototype of the first really operational helicopter, the R-4.

WITH the flight of the R-4 in May 1942, the U. S. began to pick up a strong lead over the U.S.S.R. The flight brought a U. S. Army Air Forces production order for a hundred helicopters. It encouraged wide research and development activity, with strong Government support, for the war spurred aviation progress in the U. S. as much as it hindered it in the U.S.S.R. It is likely that as many as 200 helicopter projects got under way in the U. S. and in Western allied nations.

The coming of VE and VJ Days did little to better the position of the Soviet engineers who, it can be imagined, must have been impatient to get design work off the drawing boards and into hardware. Unfortunately for them, toward the end of World War II jet aircraft appeared. These called for a whole new industrial approach to airframes and engines and compelled the Soviets to put an overriding prime priority on development and production of this new form of aircraft.

Such postponement of resumption of the Soviet rotary-wing effort afforded the U. S., and indeed Western Europe, opportunity to increase the free world's lead. In the 1945-1948 period, large numbers of Sikorsky H-6's were built and used by the U. S. armed forces. The larger H-5, destined to be the Korean war workhorse, was finally introduced. The 3-seat Bell H-13 first flew in 1945, and the similar-sized Bristol Sycamore in 1947—numbers of both being built for military and commercial use.

Experience gained from the actual development, production, and operation of these helicopters undoubtedly afforded not only America but the West an exceptional advantage. The 12-year backlog of know-how and development that these craft represent is difficult to duplicate in a new machine, no matter how great the effort.

In 1949 came at last the opportunity for Soviet helicopterists to exploit their own decades of experimental knowledge and what they had learned from their careful kibitzing of American and British applied helicopter engineering. Soviet authorities gave helicoptering a "go" order, because they considered it possible to devote a limited amount of their aeronautical development and production capability to other than combat aircraft.

In selecting the field of aviation to receive attention, it is evident that, although 4-engined piston transport aircraft were then coming into large-scale military and commerical use in the free world, the Soviets rejected such air transport. Their extant rail net was adequate for long hauls. Moreover, heavy airlift might better await the advent of turbine power, which could afford a major jump in fixed-wing airlift capability. Also, the Soviets wrongly thought that the turbine-powered bombers, then under development, could easily be modified into transports.

Although unconventional aircraft, other than helicopters, had interested Russian and Soviet engineers from the earliest days of flight study, consideration of such STOL and VTOL types appeared out of the question. No promising developments in the field had been worked out abroad, and past experience at home had shown that such craft were bound to be an even harder developmental nut to crack than helicopters.

Notoriously reluctant to expend efforts along lines which don't show the greatest promise of practical hardware, the Soviets passed over "unconventional" vertical-lift craft for the conventional helicopter.

A strong reason for interest in vertical-lift transport was the need for such craft on the atomic battlefield (the first Soviet atomic bomb went off in 1949). Surface transport could not meet all requirements, and helicopters obviously could furnish a high degree of maneuverability and flexibility. Furthermore, as the Soviets showed in World War II, their tactics favor large-scale envelopment, and here helicopters could be most helpful because they could land large assault units a hundred miles in the enemy rear.

Further strong arguments for helicopters were derived from economic considerations. The lack of a well-developed road net and truck transport system meant considerable difficulty in distribution of small consignments to rural areas not on rail lines. Another point in favor of helicopters was that they do not require prepared airfields as do fixed-wing transports.

Moreover the Soviets have a major requirement for transportation in remote and isolated areas difficult or impossible to reach by surface locomotion. These places include the Arctic, many rugged coastal and mountain areas, and the forest fastnessess of the taiga country of the north.

FINALLY the helicopter had obvious advantages for such purposes as agriculture (crop dusting), forest conservation (fire patrols and fighting), and evacuation of sick and injured from rural areas where no medical service is available.

Once the Soviets decided to give helicopters a high priority, they acted with their customary drive. Two key veterans of rotary-wing work were put in charge of design teams, with the sole mission of rotary-wing development: Mikhail Mil and Nikolai Kamov.

Alexander Yakovlev, for years the darling of Stalin and designer of the wartime Yak fighters and all Soviet fixed-wing primary trainers since 1937,

was assigned to help from the combat plane field. He was assisted by Kamov's 1928 collaborator, Skrzynski, and another old rotary-wing veteran, B. I. Serebretsov. Aeronautical research establishments, power-plant design teams, and other component specialists were ordered to assist to the utmost.

In carrying out their helicopter program, the Soviets have followed patterns of policy by now conventional in the U.S.S.R. When a Soviet ministry, civil or military, establishes a requirement for a new aircraft, the Ministry of the Aviation Industry assigns it to one of the design teams. While working, the team can call on various agencies for needed assistance, such as the work on theoretical problems which can be given by TsAGI (the Soviet equivalent of our National Aeronautics and Space Administration).

The Soviet design teams worked very rapidly. The result has been that there are in production and wide service a complete line of helicopter models to meet all civil and military requirements. Generally speaking, the quick appearance of the first batch of Soviet helicopters was due to a design philosophy which shunned any novel approaches and adhered to the sound application of quite orthodox techniques.

Indeed, the three principal large helicopters each have a basic configuration resembling that of an earlier Western helicopter. Thus the Mi-1 follows the style of Raoul Hafner's British Sycamore; the Mi-4, the Sikorsky H-19; the Yak-24, Piasecki's twin-rotor approach expressed in the H-21 and H-16.

THIS does not mean, however, that Soviet engineers have done straight copying jobs. They have followed proven "styles" in their own way. In addition, they may have done excellent work on what goes on "under the hood," as it were. There are assertions by Europeans and U. S. commercial operators who have examined some Soviet helicopters (but whose views must be subject to further verification) that the Soviets have done good work on vibration and stability problems.

These sources state that the Mi-1 (unlike most Western contemporaries) is capable of complete instrument flight in night or bad weather conditions. They report rotor-blade deicing as outstanding.

Of even greater importance is the degree to which Soviet engineers, and their production industries, may have solved (or prove able to solve) the helicopter problem all-critical in the West—the life of operating components. Such life is the controlling factor in helicopter utility, since on it depends the maintenance burden, the availability of aircraft, and the great bulk of operating costs. So far, Kamov has claimed inherent low maintenance for his contrarotating concept, and Mil has predicted the same for his helicopters.

However, as with their turbine transports, the Soviets so far have not been able to document to the West the reliability of their helicopters and have failed to furnish evidence of component life, so Westerners remain skeptical. They believe that while the Soviets may be attacking the problem vigorously, they may not yet have satisfactory solutions.

Since the solution of this problem is a direct factor of development effort and operating experience, the West cannot afford to regard the situation with any complacency. This would be a grave risk in view of the scope and tempo of the Soviet helicopter program. If achieved, Soviet solutions would have the gravest consequences, not only as regards military potentials, but as regards Soviet capability for economic penetration in undeveloped areas of politically uncommitted nations.

The roll of Soviet helicopter types is quickly called:

"Hat" is the Western code name for the smallest Soviet helicopter presently built—the ultralight Kamov Ka-10. With a special 55-horsepower reciprocating engine replacing the motorcycle one of the Ka-8, the Hat ranges only some 75 miles and has no appreciable payload. (The Soviets admit it will carry two people only in cold weather.)

It thus is strictly a liaison and reconnoitering aircraft, intended for civil (commercial fishing, geological survey, etc.) use as well as military (including submarine-based) service. It was first publicly demonstrated in 1950, a year after the new program began.

Later members of the Kamov family, all with his typical coaxial twin rotor, are the Hen (Ka-15) and Hog (Ka-18). With a 250-horsepower engine, the Hen can sustain pilot and passenger as well as a cabin. Able to range over 200 nautical miles at 75 miles an hour, it has been observed in wide use throughout the Soviet Union. Now also in production, the Hog is a beefed-up Hen, able to carry 750 pounds or 3 people just under 200 nautical miles.

ALSO rated a 3-place machine, but considerably heavier, is Mil's Mi-1 (Hare). Turned out with startling swiftness, it was designed in 1949, test flown in 1950, and in production in 1951. Numbers were available for exhibition in the Air Show that year.

With single main rotor plus tail antitorque rotor configuration, the Hare has plenty of power yet a remarkably low vibration level, like the Bristol Sycamore it resembles. Its 540-horsepower radial engine affords exceptional climb, but the claimed cruising speed is slow: around 86 m.p.h. over a range of some 180 nautical miles. Produced in large numbers, the Hare operates in a wide variety of military, rescue, medical, postal, agricultural, and fire-fighting roles.

The Poles are trying to export outside the Iron Curtain their SM-1 version, for which they claim full blind-flying capability. One quoted price, to an American firm, complete with radio altimeter, is the remarkably low one of $55,000. Although the Polish sales brochure furnishes the fullest details on the aircraft proper, it says nothing of component life, overhaul times, or spares requirements.

In 1956 Mil considerably modified the Hare design to create the Mi-3. With horsepower upped to 725 and a fourth rotor blade, the Mi-3 gains over the Mi-1 in speed, range, and altitude capability. It can carry four persons, and is fitted to carry two litter patients in external pods.

No sooner had Mil got the Mi-1

Hare into production in 1951 than he followed it with the Mi-4 Hound toward the end of 1952. Shown off in quantity to foreigners at Tushino in 1953, the Hound is claimed by Mil to have "twice the gross weight, engine power, and lift capability of the American Sikorsky S-55." He has said that when it went into production "it had no equal abroad, and in fact was several years ahead of anything built by foreign helicopter manufacturers."

The U. S. S-55 (military H-19), a 1949 development which did remarkable service in the Korean war, is indeed smaller than the Hound, but the latter bears a strong resemblance to its American predecessor. The Hound likewise resembles the Sikorsky "beef-up" of their SS-55—the S-58 (military H-34). Larger than the Hound, the S-58 didn't fly until 1954.

The major point of difference between these two American and Soviet craft, each of which has the single main rotor plus tail rotor configuration, is the clamshell doors at the rear of the Hound's cabin. These permit easy loading and discharge of small vehicles, guns, and similar heavy equipment.

As a result, the Hound appears to be an excellent military assault helicopter to land well-armed units in the enemy rear. In extensive use in the Soviet Army, it has been used in many training exercises for just that purpose.

POWERED by a Soviet version of the 14-cylinder radial engine of the same Wright-type model as used in the larger Sikorsky S-58, the Hound can carry a payload of 3,500 pounds (or 14 troops) over a 200-nautical-mile range. Holder of several internationally recognized records, it has seen much Arctic and Antarctic service. It operates widely as a forest-fire fighter, and (with external ventral hopper) as a crop duster. The first Aeroflot helicopter airlines are using a passenger version, but Mil complains that too little Soviet recognition has yet been accorded the helicopter as a mode of transport in other than rough terrain and undeveloped areas.

For civil use, the rated 2,200-pound payload is claimed to afford lift for

Above, the coaxial twin-rotor Ka-18, capable of carrying 750 pounds 200 miles. Below, the giant Mi-6, probably able to carry a normal payload of 12 tons.

Below, clamshell doors at rear of the Mi-4 Hound permit easy loading and discharge of small vehicles, making this an ideal military assault helicopter.

ten passengers with plenty of baggage. Mil claims that with a 12-passenger load such a helicopter operates at a cost of only 41 kopecks per kilometer as compared with 59 kopecks for the current 10-passenger fixed-wing plane.

Turbinized it could carry 16 passengers at only 24 kopecks per kilometer, cheaper than the Soviet Douglas DC-3 at 33 kopecks per kilometer. Mil may well be right, but until the Soviets establish a valid cost standard between free and Communist worlds, such figures mean little.

Mil's latest creation is the giant Mi-6 Hook, with a gross weight of some 80,000 pounds. The Hook is powered by two specially designed helicopter Soloviev gas turbines, claimed to turn out 4,700 e.s.h.p. each. Like the Hound, the Hook has a single main rotor plus tail rotor, and hydraulically operated clamshell doors at the rear of the cabin under the tail boom. It has won an acknowledged world's record by lifting some 27,000 pounds to 9,500 feet, which would suggest a normal payload of close to 12 tons.

Although the Hook was unveiled with fanfare late in 1957 to celebrate the anniversary of the Red Revolution, it is so large a craft that major and minor teething troubles are very likely. Modifications have been acknowledged, and production of the Hook has yet to be announced.

When such a craft does go into service, its troop-lift capacity, speed, and range can add very significantly to Soviet Army potentials. With a stated seating capacity for seventy to eighty passengers, it could also be very important as a weapon for psychological and economic cold war use.

THE Yakovlev design team is the only one in Russia to have produced a tandem twin-rotor craft. This Yak-24 Horse bears a resemblance to the Piasecki H-16 project abandoned in the experimental stage in 1956 due to lack of funds. The Soviets admit that, like that of the H-16, Horse development was not unfree from bad crashes. Indeed their account of the Horse suggests the H-16 was abandoned too soon, and required only perseverance to perfect.

Each Horse rotor is powered by an 1,825-horsepower radial engine. These are coupled by a massive transmission and shafting system so that either engine can drive both rotors. The Soviets claim that hover can be achieved with one engine out. With this power the Horse can range 200 nautical miles at a maximum speed of 110 knots an hour.

Provision of such power, plus the complex drive system, has meant a relatively poor payload-to-gross-weight ratio—a factor influencing Westerners to await the advent of turbines before proceeding with this kind of helicopter layout for major cargo lift. However, what may have made the Horse worthy of production is the way Yakovlev saved weight by substituting a fabric-covered tubular frame for all-metal construction in the boxlike center cabin section.

Although relatively inefficient for civil use, the Horse rates as a heavy military cargo helicopter with a normal payload of about five tons, and a ramp door under the rear rotor pylon affords quick handling of heavy items. In public demonstrations it has loaded passengers, two Gaz-69 light trucks, or a Gaz-69 towing a light field or antitank or antiaircraft gun. It has been in production since 1955 and is in military service in numbers.

The Horse is said to be hard to control when close to the surface because of the "ground-cushion" effect on the flow of air from the rotors—a problem affecting larger helicopters especially and requiring for solution the sort of directed research which the Soviets tend to emphasize.

As is well indicated by the way the Soviet helicopter program has been carried out, the Soviets in the future are likely to follow their standard "hardware" policy in the VTOL field. First, they will expend great energy and effort to improve and modernize their extant helicopters. From time to time they will replace obsolescent aircraft with new models representing development along orthodox lines. For instance, to be expected is exploitation of turbine power, both as to new designs of all sizes and as to conversions of extant designs.

SECONDLY, the Soviets will continue to investigate completely new concepts in the hope of achieving a major break-through in basic VTOL design. Probably funds and resources for this phase will not be as plentiful by any means as for the other, because of the traditional Soviet reluctance to invest heavily in the early exploration of unproven ideas. However, when practical experimentation and experience indicates the soundness of any given line of development, the Soviets can be expected to make virtually an all-out effort.

Under the circumstances, it is only too probable that in the years to come the Soviets will make continuous improvement in helicopter performance, and will build up large numbers of operating civil and military aircraft. The chances are that the Soviet VTOL fleets will be larger than the West's.

Moreover, if the Soviets solve the critical problem of life of dynamics systems components, or make a major break-through with some new concept of VTOL flight, then they can do much with their helicopter program, not only as regards furthering Soviet military potential but as regards economic and psychological phases of the cold war.

As a result, the Soviet helicopter program easily can be viewed as a matter of far more immediate concern than the Soviet challenge to win the race to outer space. While the Soviets are acknowledged to have a lead in the race for outer space, in "inner space" (the air close to the ground where helicopters fly) it's the American-led free world that has a marked lead.

But due to the apparently greater "glamour" of outer space, and to American preoccupation with means of waging all-out war instead of little wars and economic warfare, America has yet to recognize the challenge to her mastery of "inner space." She stands to lose her lead in this area virtually by default—a loss which could have incalculable military and economic consequences long before the first man is projected into outer space.

World Peace Through Law

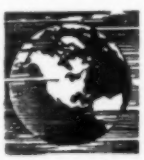
Given wise political direction, the armed forces of the free world could mobilize scientific research and technological development to devise proper retaliatory means to support international order

Eugene E. Wilson

EARLY in 1959, following the Sputnik break-through, John Foster Dulles bestowed the cachet of valid American doctrine upon the American Bar Association goal—world peace through world law—by declaring "there could be no nobler mission that our Nation could perform."

But what Mr. Dulles really asked for was an "agonizing reappraisal" of American foreign policy which he had struggled to implement in the face of handicaps indigenous to its character.

In making his request in the form of a positive mission, Mr. Dulles left open the puzzling question of how to attain that goal. However, since all the errors which had brought an advanced social order to the brink of destruction had occurred during the adulthood of men of his own generation, it is not unlikely that he realized that the answers were to be found in a review of contemporary history.



Prior to August 1914, the date when the outbreak of World War I inaugurated its current time of trouble, the whole world had enjoyed the fruits of a century of peace under international law. Since a goal which had been gained in the past, and lost through known error, could probably be regained by applying its underlying principles to correct the error, Mr. Dulles, as a lawyer, had not been willing to sweep the proposal under the rug as "impractical idealism." To the contrary, he doubtless recognized it as the only well-marked road to salvation.

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First of all, the world equilibrium which had been established at the dawn of the nineteenth century, following the close of the Napoleonic Wars, was not limited to military forces. On the contrary it involved a coordination of all of the societal forces, military, economic, technological, political, cultural, and ideological in the generation of all the elements of national power: geographic position, physical conformation, extent of territory, numbers of population, character of population, and character of government.

Equilibrium involves coordination of all the ponderables and imponderables of these elements, with added complications incident to revolutionary products created through scientific research and technological development.

But in principle today's problem is still that of bringing all forces under the control of the higher law of nature which was applied in international law. That law applied the basic principle of limitations as to *use*. It is the principle which draws the line between civilization and barbarism—the principle underlying the Ten Commandments.

Given to the Israelites during their wanderings in the wilderness following their coming out of bondage to Egypt, the Ten Commandments defined the restraints each individual must impose upon his uses of force in order to coexist in freedom.

INTERNATIONAL law simply adopted the principle to govern sovereign national states. Its primary object was freedom of the seas. Hence international law recognized freedom of access to the sources of sustenance for life on earth as a primary requisite to peace. The rules of war in international law were designed to guarantee that freedom to such as abided by that law and, contrariwise, to deny it by force to an outlaw.

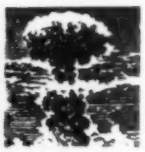
Hence international law implemented a principle of life by limiting the uses of force to lawful purposes. In so doing it applied the most elementary of all legal distinctions, that between the legitimate and illegitimate uses of force. This is a fundamental principle of government recognized almost universally whether in a tribal village or a sovereign state as a basic tenet of civilized society.

The principal general rule of war in

international law denied the use of military force against noncombatants. The rule was dictated jointly by strategic principle (economy of force) and by humanitarian considerations (religious principle); hence Arnold J. Toynbee's term, "Western Christian civilization."

Thus, when World War I became transformed from limited warfare to unlimited warfare through Germany's indiscriminate submarine campaign against enemy and neutral shipping alike, Western Christian civilization commenced its swift decline.

The German decision was taken when, confronted with the specter of defeat, and unwilling to leave the issues to arbitration at a peace conference, Kaiser Wilhelm succumbed to temptation to take the law into his own hands. Similarly, twenty years later, Britain, beleaguered by a resurgent Germany and confronted with ultimate defeat, inaugurated unlimited aerial bombardment on the night of May 11, 1940.



According to J. M. Spaight, C.B., C.B.E., former Principal Secretary of the British Air Ministry, writing in "Bombing Vindicated," published in England in 1944, this was "a splendid decision, heroic and self-sacrificing," taken behind propaganda designed to persuade the public that Hitler had begun that type of war.

However, F. J. P. Veale, an authority on international law, took sharp exception to this judgment in "Advance to Barbarism" published in London during the same year. To him this "splendid decision" was an "epoch-making decision" because it marked Britain's "first deliberate breach of the fundamental rule of civilized warfare—that hostilities must be waged only against combatant forces."

This breakdown of Western civilization has been variously ascribed to: (1) lack of suitable machinery to bring revolutionary weapons under definitive rules implementing the general principles of civilized warfare; (2) the resulting temptation for states facing defeat to breach those principles; (3) lack of suitable weapons to deter major powers from succumbing to such temptation; or (4) lack of the will to use suitable weapons to support the principles.

Against these failures, it becomes pertinent to review briefly American attitudes toward aerial warfare.

When the issue was first drawn in 1925, President Coolidge appointed a nonpolitical, nonpartisan advisory committee to inquire into all aspects of the matter. The Morrow Board rejected aerial bombardment, with its hazards to civilian populations implicit in its inaccuracy, as being contrary to the traditional American defense posture. At the same time the Board proposed a long-term development program for military, naval, and commercial aviation which made it possible for the United States to meet the challenges of World War II.

That program produced two concepts of American air strategy, both complying with the principles of international law, although that position had not been emphasized. The naval air doctrine of limited warfare produced the concept of the long-range striking force in the form of the carrier task force. The military doctrine of limited warfare produced the concept of the long-range striking force in the form of the U.S.A.A.F.

In both cases the tactics contemplated precision bombardment of military objectives in accord with such strategic principles as economy and concentration of force and others pertinent to the weapon system.

Immediately following the arrival of the U.S.A.A.F. in England, the American tactic was tested out in competition with the British tactic of low-level, night-area bombardment of urban populations. Owing to high losses by both forces incident to a lack of fighter escorts, results proved indecisive. After fighter escorts had been provided the differences of opinion persisted, with the U.S.A.A.F. unshaken as to the soundness of strategic principle.

Before any valid conclusion could be drawn, the matter was taken out of the hands of the military by the high-level political decision taken in January 1943 at Casablanca.

The Casablanca decision to launch unlimited aerial warfare against cities to destroy civilian morale paved the way for the bombing of German cities, including that of Dresden. Undertaken at the request of the U.S.S.R. after the battle lines had moved beyond the city, and while it was crowded with refugees seeking to escape the advancing Red armies, that action, according to Air Marshal Harris, originated in high places far more important than himself.

The low-level fire-bombing of Japanese cities and the atom-bombing of Hiroshima and Nagasaki, which brought Japanese civilian losses to a point half again as great as all the military losses, must be similarly considered as involving political rather than military strategy.

THESE actions, and many others, climaxed the reign of unlimited warfare initiated in World War I and rapidly accelerated through World War II. Subsequently they led to a frantic race between East and West to avoid sudden and complete defeat through unlimited nuclear warfare.

This race was climaxed with the Sputnik break-throughs from 1957 to 1959 when the U.S.S.R. preempted leadership in a technique of unlimited warfare which had finally made the capability for massive annihilation mutual to East and West.

Then it became clear that the word "win" had lost all meaning in unlimited nuclear warfare. Even less meaning attached to the massive fixed-base, air and missile-launching facilities upon which the political government had placed full dependence to deter unlimited warfare through massive retaliation. Their vulnerability to surprise attack or capture automatically precluded any selective, discriminating, or limited use of force for the reason that it allowed no time for either side to determine whether any suspicious ac-

"International law implemented a principle of life by limiting the uses of force to lawful purposes. In so doing it applied the most elementary of all legal distinctions, that between the legitimate and illegitimate uses of force."

tion by either side might have been overt or inadvertent.

This fatal vulnerability required that, for "safety's" sake, any action by either side must be countered by the other—instantly, blindly, and with every force available, bar none. This vulnerability created a state of explosive instability susceptible of detonation into a chain reaction by any bystander, innocent or otherwise.

It was a situation quite as likely to touch off a nuclear reaction as to deter one. Nor could there be assurance that unlimited nuclear war could be deterred just because it seemed certain to destroy civilization and, mayhap, humanity.

Obviously, political ineptitude had created a situation remote from the equilibrium of the nineteenth century. This fact was made appallingly clear in a report of the Committee on the Armed Services of the House of Representatives, dated March 1, 1950. After ascribing the "multiplicity of complexities" which had given rise to interservice controversy to the failure of the National Security Council to provide "a formal statement upon which the Joint Chiefs of Staff may rely as an official expression of their civilian leaders and which the Congress may have available for consideration," the Committee stressed the "imperative necessity" for correcting this defect.

OBVIOUSLY, during such an era of unstable equilibrium, with ample facilities for mutual extermination, the only rational basis for any military activity by either side lies in the establishment of a mutually acceptable set of ground rules limiting the uses of military force to those consistent with the enlightened self-interest of all concerned. However, before such rules can be promulgated, a reasonable parity or balance of forces must be established which encourages resort to other forms of competition less lethal than unlimited warfare.

Even then, in order to deter either limited or unlimited warfare by nations confronted with defeat, weapons and weapons systems must be devised which are selective and discriminating enough in the hands of a responsible authority willing and able to use them to maintain world order under world law.

"The West has permitted its singleminded preoccupation with unlimited warfare to impair its capability for limited warfare. Granting full credit to the Strategic Air Command and the Carrier Attack Force for having deterred unlimited nuclear war to date, the fact remains that the civilian government has not succeeded in deterring limited war for the past decade."

The global strategy involved contemplates the coordination of all the societal forces to that end. As to the military, a leading scientist engaged as a consultant for the armed services has suggested that the most promising deterrent, possessing the greatest mobility and secrecy and hence the least vulnerability, lies in the Polaris underwater missile-launching system, when perfected. This authority goes so far as to insist that this is the only promising system now in sight.

Doubtless underground missile-launching facilities and carrier attack forces will continue in use for some time, but at present the Polaris system offers a potential advantage of far-reaching significance to the establishment of world law. Given accurate weapons and warheads with limited yields, whether conventional or nuclear, the Polaris system, when perfected, could conceivably attack limited military objectives within urban areas under the existing limitations imposed by international law without offering justification for massive retaliation or any form other than retaliation *in kind* as contemplated by law.

Indeed, given sufficient secrecy, mobility, accuracy, and control, some such system, whether seaborne or airborne, might be used to deter both limited and unlimited warfare while still conforming to all such humanitarian considerations of international law as "prior warning," "minimum force," and protection of persons and property.

In other words, given wise political direction, the armed forces could mobilize scientific research and technological development in support of world order under world law.

Lacking such direction, the West has permitted its single-minded preoccupation with unlimited warfare to impair its capability for limited warfare. Granting full credit to the Strategic Air Command and the Carrier Attack Force for having deterred unlimited nuclear war to date, the fact remains that the civilian government has not succeeded in deterring limited war for the past decade.

The East has been quick to exploit the West's political errors by creating the most advanced forces for limited warfare and creeping aggression ever assembled. Since limited wars have occurred consistently over the past ten years, they must be accepted as the wave of the future.

HENCE the West can be charged with having concentrated all its effort on a single-minded Maginot Line effort to deter unlimited nuclear war, which it deems unlikely to occur, to the point of failure to deter limited war which, having occurred since time immemorial and with increased frequency in the air-nuclear age, seems destined to continue indefinitely.

In summary, the West must strive to achieve a state of equilibrium on the military front behind which it can establish a state of global equilibrium conducive to the establishment of world order under world law.

In light of the failure of the civilian government of the United States to pursue wise courses to this end, and in view of the unfortunate results chargeable to this failure, it would appear that this nation could hardly do better, and might continue to do much worse, than to ratify Mr. Dulles' endorsement of the American Bar Association goal.

Since that goal of world peace through world law is wholly consistent with the American philosophy, and since it takes its stand on the right side of justice and morality, its adoption alone might give impetus and direction to a well-coordinated effort to convert Western Christian civilization into a higher world order.

New Ground Force Weapons

The Army's new M60 medium tank, above, will be produced by Chrysler Corporation to replace the present M48. It is powered by diesel engines and carries a 105-mm. gun. Below are the three sections of the Redeye, a new portable, shoulder-fired antiaircraft guided weapon. Trigger-stock is at left, the missile in the center, and launch tube at right (Army photo).

Research in Ballistics

The Army Ordnance laboratories at Aberdeen Proving Ground are well equipped to investigate interior, exterior, and terminal ballistics and to compute the trajectories of guided missiles and satellites

Col. James P. Hamill

PHYSICISTS, chemists, mathematicians, statisticians, aerodynamicists, astronomers, engineers, and their supporting personnel—1,000 of them working together—comprise the Army Ordnance Ballistic Research Laboratories at Aberdeen Proving Ground, Md. These people are often called ballisticians because they apply their varied talents and their creativity to the search for knowledge on the propulsion, flight, and terminal effects of missiles. The product of the laboratories is knowledge—knowledge used by the Ordnance Corps, other Government agencies, and their contractors.

To accumulate this knowledge, the laboratories devise instruments for varied types of measurements and the computing techniques for handling these measurements. With their accumulated knowledge they evaluate existing weapons and weapons systems and propose future ones. They also prepare ballistic tables for guns and rockets and devise quality-control measures for ammunition.

The laboratories are assisted by a scientific committee and a group of consultants—all nonresident. The committee and the consultants are eminent American scientists who contribute their broad points of view to the work of the laboratories.

The origins of the Ballistic Research Laboratories are somewhat indefinite. Ballistic research, especially studies of the motion of artillery shell in air, had been carried on extensively in the Office of the Chief of Ordnance and at Aberdeen during World War I. After the war, ballistic research received excellent and continued support from Col. W. H. Tschappat who had formulated a most advanced treatment of interior ballistics in his famous text, "Ordnance and Gunnery."

Colonel Hamill is Director of the Army Ordnance Ballistic Research Laboratories at Aberdeen Proving Ground.

Colonel Tschappat came from the Office, Chief of Ordnance, in 1922 to command Aberdeen Proving Ground, and from 1934 to 1938 he was Chief of Ordnance. It is especially significant that in 1922 R. H. Kent also came from Washington to the Proving Ground.

The most significant event to bring the Ballistic Research Laboratories into being was the assignment of Col. H. H. Zornig to the Proving Ground to take charge of ballistic research in 1935. Colonel Zornig segregated the pertinent groups from the more routine testing activities and formed the Research Division.

By this action the groups engaged in ballistic research for the first time were put into a position where they could formulate programs that would meet their special requirements.

The part played by Colonel Zornig and his able assistants—Captain Simon, Lieutenant Gillon, Mr. Kent, and Dr. Dederick—in advancing ballistic research at Aberdeen Proving Ground after 1935 can scarcely be overestimated. It was primarily the foresight of Colonel Zornig that was responsible for the creation of the Research Division in 1935 and its evolution into the Ballistic Research Laboratory by 1938.

By wise and careful planning, he and his associates organized a broad program of research and of expansion of personnel and facilities that prepared the way for the tremendous progress made in ballistics during World War II and the postwar period.

The classical ballistics problems lend themselves quite well to the organization of the laboratories. Following a projectile through the initial, intermediate, and final stages of flight, requirements then arise on observing, calculating, and evaluating—both present and future.

Interior Ballistics Laboratory

Consider first the Interior Ballistics Laboratory. Interior ballistics is that branch of ballistics which is concerned with the means by which motion is imparted to a missile. In practice, the means used constitute a heat engine of one form or another. Thus the gun can be regarded as a single-stroke, internal-combustion engine, and the va-

rious forms of jet propulsion alternatively employed have features in common with gas turbines.

This being the case, interior ballistics comprises a study of an energy source, which is nearly always chemical, a working substance, and the accessory apparatus for controlling the release of the energy and directing the activities of the working substance.

Weapons are designed to operate under far greater extremes of temperature, pressure, and time than are usual in nonmilitary engines. A solid propellant is required, in conjunction with the rocket or other accessory apparatus, to release its energy in a manner that is subject to control and produce a gas which is an efficient working substance in the energy-producing cycle. It is necessary, therefore, to study the thermodynamic properties of the propellant as well as the kinetics of its decomposition.

The stability of propellants in storage is obviously a matter of importance, and better methods to estimate this stability in advance continually are being sought.

Finally, the physical integrity of a propellent charge in a rocket is a matter of critical importance, and thus it is necessary to study the visco-elastic properties of propellants and constantly to seek improvements in their physical properties. Investigations also are made into the dynamics of the propellent gases as well as the motion of the projectile inside the rocket or gun.

Exterior Ballistics Laboratory

In contrast, the field of exterior ballistics is concerned with those things which affect the flight of missiles, whether bombs, shell, or guided missiles. The Exterior Ballistics Laboratory was established for the experimental and theoretical study of missile flight and from the results of such studies to develop techniques for the design of missiles.

The factors influencing missile flight are inertia, gravity, and aerodynamic forces. Since relatively small changes in the aerodynamic-force system may drastically affect the accuracy or range of a projectile, the primary problem in exterior ballistics appears to be the accurate and reliable prediction of aerodynamic forces on new missile designs.

Modern developments in missile technology have brought a host of new problems associated with very high or hypersonic speeds, such as very high heating rates, transport properties of dissociated and ionized air, the influence of electric and magnetic fields on the flow of the conducting gas, and many others.

In the development of basic information for the exterior ballistic design of missiles, the Exterior Ballistics Laboratory relies heavily on model tests, both in wind tunnels and in free-flight ranges, to learn about missile aerodynamics. The first supersonic wind tunnel large enough for practical tests of projectile and guided-missile models built in this country is part of the laboratory's equipment.

This facility has, since its first operation in 1944, contributed importantly to solving supersonic flow problems and design of guided missiles for the Army, Navy, and Air Force. It is equipped with two test sections approximately 15 inches square, which together cover the Mach number range from 1.3 to 5.0, and a research test section with a maximum of Mach 4.7.

There are two precision free-flight ranges currently in use. The older one, called the Free Flight Aerodynamics Range, is some 275 feet long, is equipped with 45 spark-photography stations, and is used for highly precise measurements of small model projectiles. A much larger free-flight range, called the Transsonic Range, has a cross section of 25 by 25 feet and is 250 yards long. In this facility, models up to eight inches in diameter can be fired, and, due to the large cross section, tests at transsonic velocities can be made with confidence.

A third type of aerodynamic range is the controlled temperature-pressure range in which small models can be fired at Mach 11.

To study some of the problems in the regime of hypersonic velocities, a hypersonic wind tunnel, designed to cover the range of Mach numbers from 5 to approximately 10, is under construction. In the ranges, special light-gas guns have been built which can launch a model of a missile with a speed up to 12,000 feet a second. Such a gun in the controlled-temperature range can reach Mach 20.

These guns also can be used as a shock-tube and wind-tunnel combination, providing high Mach number and high-temperature flows of short duration. More sophisticated launching devices capable of propelling a missile up to about 20,000 f.p.s. are being constructed.

Terminal Ballistics Laboratory

The Terminal Ballistics Laboratory (TBL) studies the principles underlying the effects of weapons upon targets. Experimental and theoretical investigations are made of penetration, fragmentation, detonation, and shaped-charge phenomena, blast phenomena, combustion and incendiary effects, cratering, ground-shock phenomena, and nuclear effects. Knowledge in such fields is needed for the design of weapons, and is basic to evaluation studies done by other groups.

Experiments and studies are made to determine the principles governing the number, size, velocity, and spatial distributions of fragments resulting from detonations of cased high-explosive charges. The knowledge gained is employed to optimize effects of ammunition on enemy targets.

Basic experimental and theoretical studies are conducted on the production and prevention of fire damage of military significance.

Studies are made of the propagation and effects of shock waves in earth, rock, air, and other gases under varying initial conditions. Such studies are essential in the determination of basic propagation phenomena of shock and blast and also are applicable to the design of blast-producing weapons and to the design of structures capable of withstanding the effects of such weapons.

To facilitate these studies, the Terminal Ballistics Laboratory employs a large (24-inch diameter) shock tube, a 4½-inch tube, and a vertical 16-inch tube.

The study of shaped charges and high-velocity metal jets involves inves-

tigations in a variety of scientific fields and experiments with a variety of observational techniques. These techniques include the multiple-flash radiographic method which uses bursts of X-rays whose duration is of the order of 10^{-7} seconds. The optical techniques which are used include rotating-mirror cameras, Kerr cells, image-converter systems, Faraday electrooptical shutters, and ultra-high-speed framing-type cameras.

Experimental and theoretical studies are made of nuclear energy and its application to Army use. This includes studies of attenuation of neutron and gamma rays in various materials. Also included are feasibility and other studies of certain nuclear devices and liaison on problems of nuclear weapon design. A 3-million-electron-volt Van de Graff generator facility is used for fundamental nuclear physics investigations.

The Terminal Ballistics Laboratory participates in field tests coordinated by the Defense Atomic Support Agency. These tests furnish considerable information that is used in further studies at the ballistics laboratories.

Because of TBL's vast experience in measuring and predicting effects of TNT explosions and because these effects are similar to the conditions of an abnormally accelerated reactor, the Atomic Energy Commission asked the laboratory to investigate the problem of adequate design of reactor containment structures.

Experimentation was carried out on scale models of a reactor which would be used for the production of electrical power. The design data obtained will allow safe construction of power plants near large cities without the fear of harmful contamination of the surrounding area.

Ballistic Measurements Laboratory

The basic functions of the Ballistic Measurements Laboratory (BML) include performing research on new principles of obtaining ballistic data and conducting basic studies on the state of the upper atmosphere and the interplanetary medium. Through the application of these principles to the development of ordnance matériel, particularly guided missiles, and more recently of earth satellites, the laboratory is integrated into the over-all mission of the Ballistic Research Laboratories, as well as of many Navy and Air Force projects.

Small telecamera, optical recording telescope, and visual acquisition system used by the Ballistic Measurement Laboratory primarily for satellite tracking.

BML devoted considerable time to the IGY program on upper-atmosphere research. More specifically, the data collected in the early phases of the program led to more detailed studies of such categories as electron-density profiles and water-vapor distribution.

Water-vapor concentrations to altitudes of one hundred kilometers are quite important in the meteorology of the higher atmospheric levels. The horizontal as well as the vertical distribution of this important constituent can serve as an excellent tool in the study of transport and mixing processes. Further, the chemical properties of water vapor, if this constituent is sufficiently present, play an important role in heat-exchange phenomena in the atmosphere.

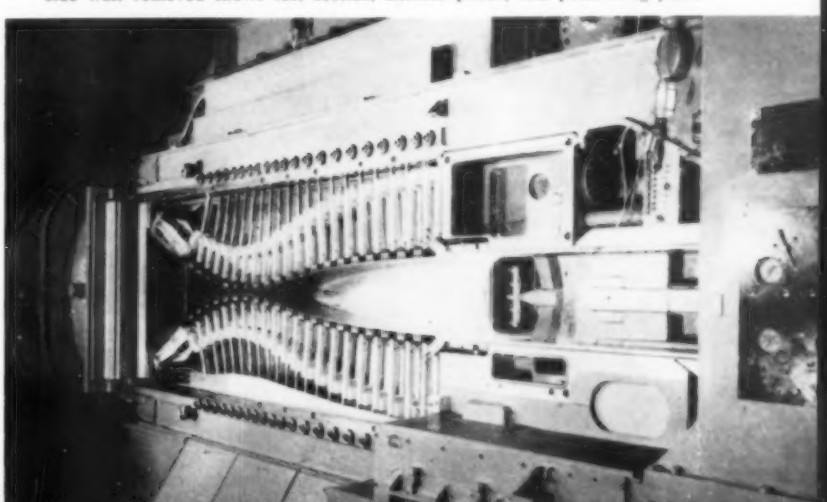
To determine the water vapor content quantitatively, the BRL developed a prototype infrared hygrometer-sun follower to be flown in a Nike-Cajun rocket. In support of the data obtained by rockets, balloon-borne dewpoint hygrometers have been flown to give independent measurements up to 30 kilometers to act as a check on the correct operation of the rockets' instrumentation.

The laboratory develops optical instrument systems and methods to determine the successive positions of missiles and satellites in space, as well as to observe other flight characteristics of these bodies. An outstanding example was the adaptation of instruments to track and provide data for the determination of the orbit of Sputnik II.

Of equal importance is the development of the required methods and equipment to reduce the data. The equipment includes a stereo-comparator to measure the positions of photographic images within one micron in conjunction with the high-speed computers to handle the huge volume of computations.

The Department of Defense is taking steps to provide the country with a means of detecting and tracking satellites that cross our boundaries and do

Exterior Ballistics Laboratory's flexible-nozzle supersonic wind tunnel with side wall removed shows test section, flexible plates, and positioning jacks.



not transmit radio signals. The increased capability of foreign countries to launch radio-silent or dark satellites which may be used to obtain military information has increased the importance of detection of such bodies as quickly as possible after they are launched.

The Advanced Research Projects Agency assigned responsibility for research and development for tracking dark satellites to both Army and Navy laboratories. The Ballistic Measurements Laboratory has used the DOPLOC technique in the 3-station radio-beam fence set up across the southern portion of the United States. The fence is tied in on both east and west with the Navy's minitrack type system.

Computing Laboratory

The primary mission of the Computing Laboratory is to prepare firing tables for artillery, small arms, mortar, rocket, and ballistic-missile weapon systems and to assist other laboratories of the Ballistic Research Laboratories and outside agencies in the solution of mathematical problems arising in their various fields. Mathematical and engineering research to develop new and better numerical procedures and to improve the performance of the BRL high-speed digital computing machines has become an essential function of the Computing Laboratory.

The rapid development of high-speed electronic digital computers naturally has led to a reconsideration of numerical procedures formerly used to solve scientific problems. Numerical analysis has developed into a branch of mathematics which is not only of importance to physicists and engineers who want numerical answers to their problems but also has aroused the interest of pure mathematicians.

As the capacity of the high-speed computers to handle complex problems has increased, the appetites and ambitions of machine users also have increased continually and frequently have surpassed the ability of known numerical analytical techniques to deal with the problems attacked. Typical practical problems of this type involve attempts to fit experimental data to theoretically determined, generally non-linear functional relations between measurable quantities.

Successful calculations have involved numerical solutions of various partial equations. The application of the Monte Carlo techniques to simulate complex events such as the engagement of a bomber by a guided missile or to the simulation of a battle are but a few examples of this kind.

The continuous evaluation and study of new engineering developments such as the use of ferro-electric materials in computer components is a necessity for any organization wanting to keep abreast of the field. Research toward a more efficient organization of a high-speed digital computer itself becomes of more and more importance as the complexity of these devices increases.

Weapon Systems Laboratory

The Weapon Systems Laboratory (WSL) performs over-all weapon system studies from an engineering and operations analysis viewpoint and conducts applied research on factors affecting system performance in order to establish desirable characteristics and proposed basic designs for new and improved weapons.

In order to carry out its mission, the Weapon Systems Laboratory studies the tactical or operational effectiveness of guns, rockets, guided missiles, and fire-control systems against a variety of targets including personnel, aircraft, tanks, armored and automotive vehicles, and emplacements. In these studies of complete weapon systems, mathematical models and operations-research techniques are applied, and high-speed computing machines or specially designed instruments are used to predict the probability of success in the tactical employment of proposed or developmental weapons.

Experiments are conducted and analyses are performed to establish target vulnerability, fire-control performance, weapon reliability, and accuracy and rate of fire as required for the systems engineering studies or evaluation.

Results of these studies indicate promising areas for applied weapons research in the Weapon Systems Laboratory as well as gaps in existing basic data which may be called to the attention of fundamental research groups in the other laboratories of the BRL.

Specifically, a direction of effort of the WSL personnel includes the conducting of experiments and evaluation determining the vulnerability of aircraft, missiles, and aircraft weapons as a basis for the comparative effectiveness of current and future weapons.

The lethality and effectiveness of atomic weapons, artillery, and mortar shell as well as artillery-type rockets against personnel and matériel targets in realistic combat situations created by war-game application comprise a major field of investigation for the laboratory.

In all areas of evaluation, an important consideration is the economic or cost-effectiveness factor involved.

Operationally, the scope of considerations includes the over-all battlefield effectiveness of armored vehicles and gun-ammunition systems. The large problems of the defending field armies and the continental United States are evaluated from the standpoint of effectiveness of antiaircraft weapons.

A branch of the Weapon Systems Laboratory is engaged in developing statistical engineering methods, sampling-inspection techniques, and grading criteria for the surveillance and quality evaluation of existing ammunition.

Future Weapons Systems Agency

The Future Weapons Systems Agency, the newest element of the Ballistic Research Laboratories, has been established to assist in the development of an aggressive, forward-looking Ordnance program of weapons research and development. This agency is continually reviewing the national potential in both production capabilities and technological advancements.

The requirement placed on this organization is carried out by a small staff of persons broadly skilled in weapons systems. The staff conducts studies on weapons systems feasibility with emphasis on military operational concepts.

The prospect study conducted by this group in 1958 showed promising help in the improvement of Army effectiveness in both limited and thermonuclear warfare.

ORDNANCE FOR THE NEW ARMY

Theme of the Forty-first Annual Meeting of the

American Ordnance Association

to be held at

Aberdeen Proving Ground, Md.

Thursday, October 8, 1959

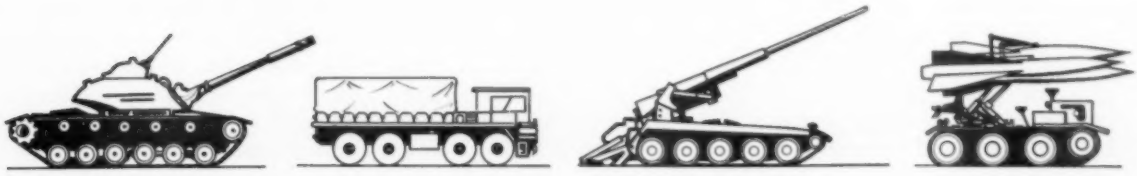
THE Chief of Army Ordnance and the Commanding General of Aberdeen Proving Ground have invited the members of the American Ordnance Association to celebrate the Forty-first Birthday of the A.O.A. at Aberdeen Proving Ground, Md., where the first annual meeting was held in 1919.

The date has been set for October 8, 1959. The program will begin at 10:00 a.m. and will end at 3:30 p.m. Tests and demonstrations will focus upon current and new ordnance to be used by the Army as it reorganizes to meet the demands of total and limited warfare.

Only members of the American Ordnance Association who have made reservations will be admitted. Tickets confirming the reservations will entitle members to a seat in the stands, a printed program, and luncheon. Each reservation is $7.00, and any surplus over Association expenses will be donated to the Army Relief Society. The closing date for reservations is September 30, 1959.

Special trains will run from Washington, Philadelphia, and New York to a siding on the Proving Ground close to the stands, and will leave from there shortly after the program is completed. Those planning to fly to APG by private aircraft are reminded that they must obtain clearance from the Military Operations Office there not later than October 1, 1959. There will be ample parking space for those who drive.

Details concerning train schedules, control-tower radio frequencies, and other information were published in the August issue of THE COMMON DEFENSE which was distributed with reservation forms to all members on July 30th. Make your friend a member and bring him. See application on page 329. Remember, reservations close Wednesday, September 30th, so *make your reservation early.*



Oil and Strategy

Fuel and lubricants are a subject of grave concern for both the free world and the Communist bloc, and without large supplies of petroleum the mobilization plans of both sides are meaningless

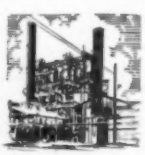
Neil Hurley, S. J.

Father Hurley, now stationed at Innsbruck, Austria, is a former member of the faculty of Fordham University, New York City. This article developed from a manuscript on the economic history of the American oil industry which he prepared for the Industrial Economics Department while teaching at Fordham.

OIL is as old as geologic time, but only recently has it figured in man's historical calculations. It is known that the Spaniards used the viscous substance in the mid-sixteenth century to coat vessel bottoms and that Indian tribes were accustomed to use oil secured from seeps to keep their war fires burning.

But the discovery and use of petroleum as an industrial product for lubrication, illumination, and as fuel in the U. S. dates back, by common estimate, to August 20, 1859, when Edwin L. Drake and "Uncle Billy" Smith sank their stovepipe casing in a field above Titusville, Pa., to become the first to drill successfully for oil.

Even more recent, however, is the significance of petroleum as a strategic military item in modern mechanized warfare. Cavalry, infantry, and artillery were the basic concerns of military strategists in the Civil War, the Franco-Prussian War, the Boer War, the Spanish-American War, and the Russo-Japanese War. The oil industry was fifty years old in America before technological advancements reached the stage where the precious fluid would contribute to a rapid succession of revolutions in techniques of war.



The dawn of the new century witnessed experimentation with a gasoline-driven engine which proved more efficient than the steam engine and more powerful than the electric motor for propelling a vehicle. The efforts of such inventors as Duryea, Haynes, Olds, Selden, and Ford created a market for gasoline, heretofore the stepchild of petroleum products. Gasoline, with a lower boiling range than kerosene, was distilled first in the old batch process and in the pre-automobile age was a drug on the market.

In 1899 the Army Signal Corps purchased three trucks which were equipped so that they might be drawn by mule in the event of breakdown. In 1900 there were only 8,000 automobiles registered in the United States, but as early as 1902 thought was given to designing motor vehicles for military service, and an armored car with mounted machine guns was exhibited at the Salon de l'Automobile in Paris. By 1910 there were 500,000 motor vehicles in the Nation.

The year 1913 was a milestone in the oil industry's history—a year in which the thermal cracking process was discovered and the Ford method of assembly-line production was inaugurated. The former process improved the yield of gasoline derived from crude oil and made possible a cheaper fuel. Mass production of standardized automobiles, on the other hand, brought down the high price of cars. The oil and automotive industries were definitely wedded as lowering war clouds gathered over Europe in 1914.

IF, as experts judge, the First World War unleashed total war as an experience unknown to mankind, then oil must take credit for the amazing striking power and mobility of armament that manifested itself in the years 1914-1918. Automatic arms for the infantry had to be well oiled; heavy guns and artillery had to be regularly greased and lubricated to ensure maximum effectiveness; tanks and airplanes, first used tactically together by the British in November 1919, had to be fueled and refueled; battleships and destroyers, cruisers and submarines, stayed afloat or underwater by means of petroleum products.

Oil, in partnership with steel, rubber, and electricity, effected a revolution in mobilization plans. From then on the home front became a military objective, first, because it produced the essential items that constituted the new concept of mechanical warfare and, secondly, because mechanical warfare could reach beyond the lines to strike

at the domestic sources of production.

Procurement and logistics as essential tasks of modern warfare were seen to be basic concepts. England, as mistress of the seas, sought to block the Central Powers from access to strategic materials, whereas Germany countered with submarine warfare, a tactic that led to the sinking of American vessels and ultimately to our entrance into the war.

The British Government at first detained U. S. oil tankers, but the temporary threat of Marshal von Kluck's forces near Paris and the desperate need of the Allies for petroleum supplies changed the British attitude. By 1916 it was rather evident that the marine operations of the major American oil companies were enjoying the tacit sanction of the British Admiralty. This was undoubtedly the reason why the German War Ministry gave the signal for all-out submarine attack on American tankers in the early part of 1917.

A petroleum crisis was evident in the Allied camp at the end of 1917, as a result of Germany's successful U-boat warfare. The convoy system served to reduce losses but increased the transatlantic passage time of tankers by five days. Germany had access to the rich oil supplies in Romania and Galicia, while the fuel stocks of the Allies in Europe dwindled to the point where it was feared the British fleet might have to be partially demobilized. Marshal Foch said that, without oil, defeat was inevitable.

TO alleviate the critical shortage, French distributors associated themselves in a limited liability company and sought, under contract and strict government regulation, to supply the French Government with oil. In addition, the United States Government and the American oil industry cooperated to meet the urgent requests for help which the French and British sent to Washington. American oil companies volunteered fifteen new tankers to be chartered, under direction of the U. S. Shipping Board, to Allied governments at one-half of the prevailing market rate.

As the flow of petroleum products swelled, an acute strain became evident in the transportation network. Besides moving crude oil to the refineries and refined products to the war zones, tankers had to be allocated for indirect war purposes. Pipelines suffered from the fact that they carried only one-way traffic. Another problem arose from the fact that gasoline conforming to U. S. Navy specifications was not suited for use, say, in British motor lorries, but this quality deficiency was eventually remedied.

It was necessary for the War Shipping Board to requisition more and more vessels of private company fleets until by the spring of 1918 most private vessels were in Government service.

The demand for gasoline in unheard-of quantities called for far-reaching shifts in refining installations and techniques. The Burton-Humphrey's cracking process was a providential discovery for increasing gasoline yields; nevertheless the military specifications for aviation fuel were such that facilities had to be adapted to manufacture a more volatile gasoline with a higher octane number.

In 1918 the U. S. Fuel Administration was established to stabilize the supply and distribution of petroleum supplies and to issue procurement orders. The availability of shipping tonnage enabled America to furnish inestimable aid to the Allies by way of deliveries of gasoline and other fuels.

In addition to Government wartime agencies interested in petroleum requirements for the mobilization program, an Advisory Committee on Petroleum was formed with members drawn from top-echelon levels of private oil companies.

The end of the war gave military experts everywhere the opportunity to assess the many innovations which total war and mechanized military operations created. Any serious peacetime mobilization plan now had to include provisions for rapid transportation of troops and supplies by means of fuel-driven locomotion—be that ship, truck, airplane, or train.

Since gasoline sales furnished a solid support to the oil trade, the industry consolidated its position in the 'twenties through forward and backward vertical integration. Many oil companies purchased oil leases and producing properties to obtain a steady supply of the subterranean crude oil and to ensure continuous runs of the refineries. Oil producers reached forward to secure dealers and marketing organizations.

Fully aware that oil was a major item in the product mix of military energy requirements, the industry became conscious of its strategic role and pursued policies of conservation and proration as well as disaster-control programs.

WHILE in the 'twenties the automobile was the greatest single factor in the oil industry's increased sales, attention was being given to the military and civil needs of the aviation industry which then was stirring in its cocoon.

At first only a means for reconnaissance and guiding artillery fire, the airplane in World War I soon became a weapon of attack through its ability to spray targets with machine-gun fire and bombs.

With domestic plane production numbered at 789 in 1925 and then at 6,034 in 1929, it was difficult to think in terms of strategic bombing as later understood in World War II. Planes gradually were pressed into service for such diverse uses as crop dusting, land surveying and aerogrammetry, and passenger air-freight and mail delivery. The Kelly Act of 1925 authorized the Post Office to contract with private plane operators to carry mail.

With the increase in speed and weight of airplanes, it became possible to deliver destruction within several hours from a distant base as the Italian campaign in Ethiopia and the Spanish Civil War demonstrated. Thanks to the Civil Aeronautics Act of 1938, the aircraft industry became quite stabilized.

As of 1940 the aviation industry consumed over 88 million gallons of gasoline as compared with 28 million gallons in 1931. Fuel-oil demands before the outbreak of hostilities in Europe in 1939 increased due to the accelerating

rate of conversion to diesel power units by the fleets of the world.

The German High Command's blitzkrieg strategy utilized the Panzer-Stuka team to combine mobility and striking power—a strategy that was dependent upon motor-propelled vehicles using gasoline, diesel fuel, oils, greases, synthetic rubber, explosives, and other derivative products of oil.

The National Socialists, conscious that most basic war materials came from foreign sources, initiated a four-year plan in 1936 to build up capacity in such items as synthetic rubber, synthetic oil, and synthetic textiles. Since less than 30 per cent of Germany's iron ore, petroleum, and rubber supplies came from domestic production in 1939, the concept of the "lightning thrust" was logical—an effort to achieve sudden victory with matériel which was otherwise inadequate to sustain a prolonged war.

NO greater testimony to the indispensability of oil in modern warfare can be given than a study of allied strategic bombing aims in World War II. Shortages of German oil products began to appear as early as 1942 due to RAF area raids and precision attacks. In August 1943, American and British bombing forces combined in a low-level raid on the Ploesti oil fields.

A year later the oil industry was selected as the major allied bombing target, and by July every major synthetic oil plant had been hit at least once. This naturally precipitated a crisis in aviation fuel, leading to ineffective opposition on the part of the Luftwaffe. As of July 1944, aviation gas production was down to 17 per cent of April figures.

Plants were bombed as soon as they were restored, so that continual heavy air attacks up till March 1945 offset such countermeasures as plant dispersal and underground construction.

What were some of the dire effects which these bombings of oil-producing facilities triggered? As early as August 1944, German pilot training had been reduced for lack of gasoline, and testing time for aircraft engines was shortened to the point of danger. Furthermore, the mobility of German Panzer divisions in the field was seriously hampered by declining supplies of motor fuel. Since oil was produced in industrial complexes together with other critical items, shortages due to bombings appeared for synthetic nitrogen (necessary for fertilizers and explosives), methanol (vital for the production of TNT, hexogen, and high explosives), and synthetic rubber.

"No greater testimony to the indispensability of oil in modern warfare can be given than a study of allied strategic bombing aims in the Second World War."

The paradox was that, while the German aircraft industry was bustling with activity turning out airplanes, large portions of the German Air Force were grounded for lack of fuel.

As a heavy importer of critical materials, Japan also was heavily dependent upon oil for prosecution of its war effort from 1941 to 1945. Here American strategic bombing, which did not begin till May 1945, had little effect for the simple reason that Japanese refineries were practically at a standstill due to the blockade by the Navy. American submarines, surface craft, and aircraft so harassed Japanese shipping that only the tiniest trickle of crude oil came into the home islands from suppliers such as the Netherlands East Indies and French Indochina.

Japan had been quite far-sighted in stockpiling crude oil prior to the beginning of the war, but the passage of time depleted these stocks and caused adverse chain reactions in the production of machine tools and aircraft as well as immobilizing transport facilities and engines of the navy and air force.

Just as oil supplies proved to be an Achilles' heel in the German and Japanese war economies, so was oil the factor which floated the allies to victory. Of every two tons of exports to our allies and troops, more than one ton consisted of petroleum in some shape or form. Oil was estimated to have constituted 65 per cent of all the war tonnage shipped overseas.

With the loss of the Malay Peninsula and the Netherlands East Indies, some 95 per cent of the United States rubber supply was cut off. Here is where the infant petrochemical industry stepped in to help. For a number of years American and German chemists had been working on means to derive synthetic chemicals from petroleum or natural-gas hydrocarbons and to further process these derivatives into such end products as rubber, paint, textiles, detergents, and drugs.

With a Government investment of $700 million, 44 synthetic rubber plants were constructed and operated by private companies. These plants soon had a combined yearly production of a million tons of synthetic rubber.

Since Texas, Oklahoma, Louisiana, and Kansas supplied 60 per cent of America's crude oil in the period from 1940 to 1945, it was understandable why the emergency rubber program would concentrate synthetic production in the Gulf Coast area.

THE petroleum industry can well be proud of its war record—it furnished the Government with immense supplies of 100-octane and automotive gas, diesel fuels, lubricating oils and greases, heating oils, bunker fuels, toluene (for making TNT), alcohols, and innumerable specialty products. Oil released valuable manpower for more essential tasks by powering transportation and farm equipment and industrial machinery.

Annual output rose from 1.4 billion barrels in 1941 to 1.7 billion in 1945. The high-water mark was reached in August 1945 with nearly 5 million barrels being produced daily. However, by the end of 1945 the reconversion plateau of 4.5 million was reached. Industrywide cooperation and the work of the Petroleum Administration for War (created on December 2, 1942) deserve the credit for the amazing increase which American oil production showed during the war years.

In 1942 German submarines threatened the movement of petroleum to the Eastern seaboard in tankers. In February a dozen tankers were sunk with another dozen each in March and April and fourteen in May.

It obviously was necessary to develop as rapidly as possible a substitute system of overland transportation. Remedies were round-the-clock use of trucks, more efficient routing of deliveries, elimination of back and cross-hauling of oil trucks, the removal of railway tank cars from moth balls, and the construction of the "Big Inch" and the "Little Big Inch" pipelines. Both lines, later sold to private companies with the right of recapture in case of an emergency, had a combined capacity of 535,000 barrels a day.

All in all, 35 major pipeline projects were undertaken during World War II at a total cost of $333,648,000, of which $154,206,000 came from Government revenue. The pipeline activity of the war years added more than 11,000 miles of trunk and gathering lines, plus the relaying of more than 3,000 miles of existing pipelines in new locations and the reversal of 3,000 miles of other lines. The industry's achievements were realized despite hurricanes, blizzards, delayed material deliveries, refinery breakdowns, and power complications.

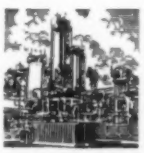
On the home front the marketing divisions of the oil companies were adjusting to the changed conditions of war. Accustomed ordinarily to expanding wholesale and retail outlets, they had to contend with the voluntary conservation of gasoline, the limitation of deliveries to service stations, card rationing with customers, and the shortage of rubber as a limiting factor on gasoline usage.

MEANWHILE our logistic lines were spread out far and thin, reaching to the South Pacific, the European theater of operations, to Russian and British supply depots all over the globe. The mechanized equipment which molded the military revolution of World War I was definitely a museum piece compared with the "hardware" of World War II. Amphibious craft, attack ships, and airplane carriers were conspicuous in every area, whether to enable an island like Tarawa to be captured or a river like the Rhine to be crossed or a decisive battle such as Midway to be won.

Russia had to rely on lend-lease oil to supplement her own supplies from the Black Sea and Caspian Sea regions, otherwise the tanks, artillery prime movers, and field artillery, with which the Commissariat for Automotive Production supplied the armed forces, would have been of little use.

The end of World War II witnessed increased research and development on the part of the U. S. Government and private companies in new weapons such as jet planes and guided missiles.

Korea with its concept of "limited war" revealed clearly how significant oil will be in keeping Russia from shrinking the free world's perimeter. The doctrine of "massive retaliation" as a deterrent to enemy attack is executed today in the form of intercontinental bombers such as SAC's B-52 which requires four tank cars of fuel in order



to attain altitudes in excess of nine miles. The arms race may make weapons obsolete, but it does not seem probable that it will obsolete the fuel needed to deliver them.

The developments in the past few years in the international politics of oil indicates how easily this precious underground substance, virtually unknown more than a hundred years ago, could swing the scale in favor of either of the two major blocs. As of 1958, the U.S.A. had produced 310 million metric tons of oil in contrast to the U.S.S.R.'s 115 million tons. However, Soviet economic plans call for a production figure of some 230 to 240 million metric tons of oil by 1965.

The chink in the armor of the West is the tendency of Egypt's Nasser to use oil as a lever to promote nationalistic causes in the Middle East. In 1957 the Middle East region produced 13 billion barrels of crude oil—one-fifth of the world's entire output. About 90 per cent of Western Europe's oil comes from this area, which contains some seventy per cent of the world's known crude-oil reserves.

"Oil, in partnership with steel, rubber, and electricity, effected a revolution in mobilization plans; the home front became a military objective."

Although the Western nations are strongly represented in oil operations in regions such as Saudi Arabia, Iraq, Iran, and Kuwait, Nasser has shown what his strategy is. In his autobiography, "The Philosophy of the Revolution," Nasser described the ideal Arabian strategy as one which would use the oil of the Middle East to force Europe and the United States to come to terms.

This strategy was put into force after the British attack on Egypt, October 31, 1956, when the Suez Canal was blocked and a few days later the pumping stations of a major pipeline across Syria were blown up. Because major oil companies in America acted quickly in tapping huge Gulf Coast reserves, it was only a matter of weeks before the U.S.A. was shipping some 950,000 barrels of oil a day to Western Europe.

The tanker shortage plus the unpredictable temper of Nasser raised the problem of a multibillion-dollar "crash program" to build a large fleet of oil tankers which could at any time sail around the Cape of Good Hope, if not through the Suez Canal.

The various contingencies of politico-military factors in the Middle East are sending the major American oil companies into a frenzy of activity and planning they have not experienced since World War II.

YES, oil is the subject of grave concern for both the free West and Soviet Russia and her satellites. The mobilization plans of both blocs are meaningless scraps of paper without large supplies of petroleum. Both the United States and Russia have rich native resources and, strange to say, both have concentrated petroleum-processing plants in highly vulnerable seaboard areas—America in the regions of the Gulf Coast, Atlantic Coast, and Southern California; Russia in the Baku regions near the Caspian Sea and further north near Batum on the Black Sea.

Oil has turned the tide of victory in two World Wars in this century and with the Middle East situation as volatile as it is, it may well turn the tide again in any future world conflict.

Our Future Scientists

Bright prospects are disclosed by symposium for young students

Peregrine White

OLDSTERS who watched the North Carolina Junior Science Symposium of 1959 from the wings might take issue with the tag, "future scientists," as applied to the alert young people who participated in this event. There were 450 high-school students and 80 teachers involved, drawn from 125 high schools throughout the State of North Carolina.

The youthful participants quickly showed that they already have keen minds, imagination, and an informed background in science that would astonish their elders.

Take the questions they asked of a panel of experts at the Curbstone Clinic session. Sample: Water becomes compressed as it cools down to the freezing point. Then it expands when it turns to ice. Why is this so? Or this one: What fills the space between the electrons and the nucleus of atoms?

Questions like these, by thousands, filled the air at this meeting, held under the joint auspices of the Office of Ordnance Research, U. S. Army, and the North Carolina Academy of Science. The OOR is located on the campus of Duke University. It is the Ordnance Corps administrative office for a $5,000,000 program of basic research sponsored by Ordnance, and carried out under contract at colleges and universities all over the United States.

The Junior Science Symposium was instituted for the first time in May 1958, the brainchild of Col. George F. Leist, Commanding Officer of the OOR. He conceived the idea as a result of reading the testimony in Washington of Dr. Edward Teller, apropos of Sputniks and America's general scientific posture, including the vast problems having to do with high-school education, scientific and nonscientific, throughout the country.

Mr. White is Scientific Information Officer of the Office of Ordnance Research, U. S. Army, Durham, N. C.

The plan of the symposium centered in part on the aim of recognizing intellectual attainment at the high-school level. During the three days of the symposium the participants heard papers by nine high-school seniors who gave excellent accounts of original work they had undertaken as an adjunct to regular classroom studies.

Each morning the entire participant group met together and heard three student papers plus a lecture by a scientist of the host institution. Duke University, the University of North Carolina (Chapel Hill), and North Carolina State College (Raleigh) cooperated with the sponsors. The meetings took place at each institution in turn. In the afternoons the students were divided into three groups, each of which visited the laboratories of the three universities.

On the final evening a "Curbstone Clinic" was staged. Ten experts, drawn from research circles in industry, government, and the university, undertook the hazardous task of responding to questions from the floor on all manner of subjects related to science itself, science curricula, and the employment opportunities of science.

It is fairly clear that no area or single group within the United States has any monopoly on the tremendous national problem of science education. We know full well that our military posture of today rests upon our current scientific and technical capabilities. That of tomorrow will depend upon the upcoming generation of young Americans currently pursuing scientific courses in high schools, colleges, and universities.

THE format followed in North Carolina in 1958 and again in 1959 appears worthy of being tried in other parts of the country. These meetings generate many useful values, popularize and promote the study of science and mathematics at high-school level, and kindle respect for intellectual attainments among high-school student populations. They provide the participants with the tremendous stimulation of direct contact with great scientists and the deep joy with which they carry on their lifetime work. They provide teachers with ideas and a renewed faith in the importance of their function.

Through the State and local officials who are involved in the planning, and also the families of the student participants, the symposia generate a new public perspective and awareness with respect to improving the opportunities provided by public schools.

The national crisis in science and education is real. What happened in North Carolina, under the aegis of the Office of Ordnance Research, is but one approach to the total problem. Within its limits, it appears to have been supremely successful.

Defense Highlights: Monthly Review and Outlook

• **Retired Officers in Industry.**—The integrity of the civilian official and the military officer, both active and retired, and the common sense of industry are all under examination by the Subcommittee for Special Investigations of the House Armed Services Committee. The emphasis has been on determining if senior retired military officers employed by industry were using their acquaintances in the Pentagon to the detriment of the taxpayers and the defense program.

The hearings were organized rapidly when unsubstantiated accusations were made that retired officers were influencing contract awards. A rider on the defense appropriation bill almost passed the House that would have required all defense contractors to drop from their employ any admirals or generals retired less than five years.

F. Edward Hébert, able subcommittee chairman, let it be known that he was seeking the facts in order to determine what corrections should be made in the present, somewhat confused pieces of legislation regarding the restrictions on retired officers seeking employment.

At the outset, Deputy Defense Secretary Thomas S. Gates testified that the Defense Department sees "no reason why employment of retired officers (by industries with defense contracts) should be forbidden. Any such course would work a grave injustice, not only on the individual, but also on the industry which may well find that the administrative skill and high professional and technical ability of the retired officers cannot be duplicated at any price."

Secretary Gates' testimony was consistently reaffirmed in the statements and answers by the many retired military leaders who appeared. There is and must be close cooperation between the Defense Department and industry if we are to develop and produce the terribly complex weapons needed for the country's safety. It is not only unfair to legislate retired officers into second-class citizens—it deprives industry and the Nation of the very men best qualified to stand at the elbow of industry and help them to analyze and evaluate the weapons they are developing.

Although no one put the shoe on the other foot in questioning the integrity of officials in the defense establishment who might be "influenced," Vice Adm. R. B. Carney, who holds several offices in industry, did remark that military procurement practices were so complex that "you would have to have (influencers) spaced ten feet apart to make sure that all the points were covered."

Admiral Carney, Gen. Omar N. Bradley, Adm. A. W. Radford, other retired military leaders, and Secretary Gates all stressed that neither now nor in the past had they known of any attempt by retired officers to influence procurement decisions.

Spokesmen for industry made it clear that they are aware of the present restrictions on the functions a retired officer may perform and that the technical assistance of these officers is invaluable in their companies' role in the defense program.

It is understood that the Subcommittee's recommendations will not be made to Congress until the next session opens in January 1960. It is expected that Congressman Hébert in his great wisdom will "influence" the Congress to clarify and convert existing legislation so that the small but effective pool of talented manpower—men who have proved their integrity and loyalty over years of service to their country—can continue to devote their knowledge to help industry keep America strong.

• **Money for Missiles.**—Ballistic missile funds were increased in a final Defense Department appropriation bill with about $160 million added to the Air Force programs for Atlas and Minuteman. The Navy's conventional carrier was thrown out, but funds to plan a second nuclear carrier were added. Air-defense weapons were partly restored in strength, with the Air Force Bomarc and Army's Nike Hercules receiving close to the amounts originally requested, and the Defense Secretary was authorized to transfer more funds into these programs if needed. For the Army Nike Zeus antimissile missile, $137 million was added to accelerate the program.

The Nike Zeus story has been presented in a most interesting and provocative manner by the *Baltimore Sun*. It is told in a booklet entitled "Countdown to Survival," prepared by Mark S. Watson, the *Sun*'s military correspondent and a frequent contributor to ORDNANCE magazine, and is taken from his numerous articles on the subject.

The background, present status, and urgent need to speed up Nike Zeus, our only antimissile missile in an advanced state of development, are described with amazing detail within the limits of security.

• **Nuclear Merchantman.**—The N.S. SAVANNAH, this Nation's first nuclear-powered merchant vessel, was launched successfully at Camden, N. J., a week before Vice President Richard Nixon and Vice Adm. H. G. Rickover had to make strong representations in order to view the engineering plant of the Russians' first nuclear-propelled ship—the icebreaker LENIN. Although Admiral Rickover had conducted Russian visitors through the SAVANNAH's plant, he was to be denied a similar privilege at the Leningrad Shipyard.

The American party reported that the LENIN's reactors appeared similar to those we have developed and that the ice-

breaker should be ready for trials in October as planned by the Soviets.

Historically it is interesting to note than in 1818 the auxiliary steamship S.S. SAVANNAH was the first vessel partly powered by steam to cross the Atlantic. The nuclear ship N.S. SAVANNAH should make her first crossing in late 1960.

Nuclear-powered naval vessels of the United States now include the guided-missile cruiser LONG BEACH (CGN-9) launched in July at the Bethlehem Steel Company Shipyard, Quincy, Mass. Also three more nuclear-engined fleet ballistic missile submarines have been ordered, two to be built at Electric Boat Division of General Dynamics Corporation, Groton, Conn., and one at the Newport News Shipbuilding and Drydock Company. The submarines will be of the new ETHAN ALLEN class, larger than the first Polaris-launching subs of the GEORGE WASHINGTON class.

• **Civilian Military Liaison.**—There is a Civilian-Military Liaison Committee composed of eight members—four from the National Aeronautics and Space Administration headed by their Deputy Administrator, Dr. Hugh C. Dryden, and four from the Department of Defense, led by Roy W. Johnson, Director, Advanced Research Projects Agency.

These eight men meet under the chairmanship of W. M. Holaday, formerly Director of Guided Missiles for the Defense Department, to adjust jurisdictional differences between their two organizations in order to coordinate civilian and military space programs. Under a new charter the CMLC no longer has to wait for a request from NASA or the Defense Department to start mediations. Thus, these two vital organizations of the Government plan to avoid unnecessary duplication free of outside interference.

• **Success and Failure in Missilery.**—Recent missile achievements among the "old reliables" are the third round-trip flight of an Air Force Snark long-range air-breathing missile that now has logged about 7,600 miles and the twenty-ninth successful consecutive launching of an Army Redstone ballistic missile including test and tactical flights and use as a first stage in Jupiter satellite launchings.

The recently developed Army missile, Hawk, for use against low-flying aircraft, has gone into service at Fort Bliss. The production version of Hawk will be assembled at Red River Arsenal, Texarkana, Tex., under Raytheon Manufacturing Company supervision, using that company's electronic packages, motors from Aerojet General Corporation, airframes by Northrop Aircraft Company, warheads from Iowa Ordnance Depot, and shipping containers of the Williamson Company.

The latest Navy weapon that might be classed as an underwater "missile" is Astor—a new electric torpedo being developed by Westinghouse Electric Corporation.

Missile failures, several in a row, in Atlas and Polaris firings, brought out a flurry of questions in Congress and caused Defense Secretary McElroy to announce a 60-day delay in the completion date for Atlas. The Navy insists that Polaris will be operational late next year in spite of a series of test failures and, on the strength of a successful Atlas shot recently, Lieut. Gen. B. A. Schriever, Commander, Air Research and Development Command, told Congressmen that he believed Atlas would be up to schedule on the long-range plan.

It is evident that missile reliablity demands the greatest engineering skill and, as Dr. Abe Silverstein of the National Aeronautics and Space Administration said, "Firing on the basis of hysterically meeting a date is a mistake."

Dr. H. F. York, Defense Department Director of Research and Engineering, was more explicit. He said: "We have gotten somewhat frantic about catching up with the Russians. . . .We have not been willing to do the basic engineering required."

To the foregoing, all down-to-earth, short-haired engineers have replied: "Yea, verily!"

• **High-Level Inspection.**—The Pentagon's three military chiefs, led by Defense Secretary McElroy, inspected the headquarters of the Strategic Air Command at Omaha, Nebr., and the North American Air Defense Command at Colorado Springs, Colo. It appears they wished to see for themselves two foci of controversy—the question of strategic air control of undersea ballistic missiles such as Polaris and the overriding control of all its triservice personnel recommended by Norad.

• **For Space Exploration.**—Radio-telescope development is receiving great emphasis as an essential part of space exploration at the Air Force Cambridge Research Center in Massachusetts and at the Naval Research Laboratory. Dr. Jules Aarons, chief of radio astronomy at Cambridge, and his team of young scientists have installed an 84-foot-diameter "saucer" at Hanscom Air Force Base.

With it, they are conducting research in the use of radio astronomy in space navigation, particularly the study of noises received from various stars and the amount of diffraction that can be expected under changing atmospheric conditions. The telescope could be adapted to detect earth satellites and missiles.

The Cambridge telescope also has been used to exchange signals bounced off the moon with the 250-foot-antenna telescope, at present the world's largest, at Jodrell Bank near Manchester, England.

The main project of the Naval Research Laboratory is a radio telescope with a 600-foot-diameter saucer to be installed near Sugar Grove, W. Va. James H. Trexler, NRL director of the project, expects that the telescope will be able to reach out into the universe about 38 billion light years—some 19 times farther than the 200-inch telescope on Mount Palomar, Calif. Completion date is 1962; budget, $79 million, weight of moving parts, about 20,000 tons.

• **Surface Skimmer.**—A British-made surface skimmer, the Hovercraft, made the first extended flight recorded for such a vehicle when it crossed the English Channel recently.

The 20-by-30-foot oval craft, flying a foot above the water with a 3-man crew, made the trip in about 2 hours at an average speed of 11 miles an hour.

Weapons Reappraisal

An Editorial

THE ability of the Nation's industry to produce ordnance of superior quality and in sufficient quantity is a matter of great concern to the American Ordnance Association. In past wars, the problem of what to produce was easy—quantities of every weapon under development followed by those on the drawing board. Later—often too late to be used—new developments were produced. The time lag was about two years.

In this era of cold war and threat of total war, most of our arms must be in hand, yet the rapid pace of scientific and technological advances in the art of armament presses hard on our industrial and military planners to keep abreast of the lightninglike changes. Industry flounders in a morass of shifting emphasis on the weapons it is trying to produce.

The military logisticians seem to be many steps behind in furnishing the weapons needed by our fighting forces that are now equipped mostly with obsolescing arms and a few random samples of superior weapons. There are possibly exceptions such as strategic and tactical aircraft and air-to-air missiles.

So far we have been lucky when the cold war has flared out at some hot spot. We kept the situation in hand with small units equipped with relatively conservative armaments. If these situations had expanded in intensity, as in Korea, again sufficient quantities would have been lacking, especially in sophisticated weapons.

All the services—Army, Navy, Air Force, and Marine Corps—have reiterated their need for increased quantities of modern armaments. They point to the large list of missiles and rockets, the small atomic weapons, the startling new underwater ordnance, and the many types of improved auxiliary equipment. They note that these superior weapons are ready for production in many cases but are not being produced in sufficient quantities. This dilemma is explained as due to an endless spiral of increasing costs of new developments interlocked with a spiral of rapid obsolescence brought on by the leaps in technology.

A solution is needed to counteract this problem of spiraling costs and obsolescence more effectively. For although the United States seems to be well prepared to retaliate in the case of a devastating surprise attack, it would still be important to have arms with which our surviving citizens could fight back. In a prolonged "hot-spot" war or a simultaneous number of them, our meager supply of modern armaments would be exhausted quickly.

The situation with respect to insufficient arms seems to be the main reason for the clamor heard on several sides directed at the Defense Department to "reorganize," "merge," "integrate." Such vociferous suggestions appear to be hasty and unfair since the Department of Defense has not fully completed its recently legislated reorganization. However, the fact that action is demanded shows that there is a healthy desire for improvement with no self-satisfaction with the *status quo* of our national-defense posture.

In place of another reorganization a thoroughgoing reappraisal seems to be in order—reappraisal on a continuous basis in keeping with the acceleration of technological progress and growing unrest in much of the world.

ONE might then ask: What is the function of the Joint Chiefs of Staff and the National Security Council; and did not the military and civilian defense leaders meet for their annual conference in Quantico in June to reappraise?

The Joint Chiefs now have a dual role of planning and "operating" under the latest reorganization and naturally must appraise situations before they perform either function. The members of the National Security Council must appraise a situation before making decisions, yet each is involved in arduous Government executive tasks. At Quantico it is unlikely that time permitted any carefully considered appraisal.

The business of these bodies is conducted, as it should be, in secrecy so that we cannot say that they do not reappraise, periodically, our national strengths and weaknesses relative to our world position. It is apparent, however, that the state of our armament preparedness seems lopsided, many industries are confused, and there is a clamor for action. Therefore, one concludes that a more thorough and continuing reappraisal is in order.

Perhaps we have achieved the optimum structure of our defense establishment—there have been few changes in the past six years—but international relationships have been changing, and technology has been accelerating.

Tension in the world from Berlin through the Middle East into Africa and the Far East certainly has not diminished, while some of our allies appear to be less cooperative than in the early days of NATO. The impetus of space exploration promises many scientific advances that can be expected to materialize sooner than once believed possible as the urgent drive to expand our scientific and engineering efforts rapidly pushes back technological barriers.

Thus, international matters demand that we keep our weapons up to the minute in quality and quantity while technology is tugging at us to wait for the next scientific advance. Only by constant reappraisal can we make full allowance for these rapidly changing developments, both the inimical and the progressive, in order to use them to our best advantage for the maintenance of freedom in the world.

New Military Vehicles

The ¾-ton 6 x 6 utility truck XM408, above, is designed by Ford Motor Company for airborne operations and for use over all types of terrain. The Larc-5, below, is the Army's first all-aluminum amphibious craft. Built by Borg-Warner Corporation, its boat-shaped hull can move through water at 10 m.p.h. and over highways at up to 35 m.p.h. (Army photos).

ASSOCIATION AFFAIRS

Maj. Gen. August Schomburg Addresses New York Post Preparedness Meeting

Maj. Gen. August Schomburg, Deputy Chief of Army Ordnance, was the honored guest and principal speaker at the spring meeting and industrial preparedness dinner of the New York Post on May 26th. More than four hundred representatives of the armed services and industry from the metropolitan New York area were present. The meeting, held at the Hotel Astor, was presided over by Lieut. Gen. Leslie R. Groves, president of the Post.

A feature of much gratification to his associates was the presentation to Col. Edward F. McCrossin of the Secretary of the Army's Certificate of Appreciation for Patriotic Civilian Service. The certificate, presented by General Schomburg, cited Colonel McCrossin's noteworthy contributions to the development of operational Nike missiles and his leadership in the procurement of the Jupiter guidance system which made possible the successful Explorer I.

Colonel McCrossin, president of McCrossin and Company, consulting engineers, has been civilian chief of the New York Army Ordnance District since 1953. He is a member of the advisory board of the New York Post and represents the Post on the national A.O.A. Council.

The citation was read by Maj. Gen. R. G. Butler, commanding general of the U. S. Army Ordnance Special Weapons-Ammunition Command.

After the presentation, Col. Leo A. Codd, executive vice-president, A.O.A., extended the congratulations and appreciation of the national Association to Colonel McCrossin for his long and unselfish service to the Nation.

General Groves introduced General Schomburg as an Ordnance officer who has demonstrated by his achievements the advantages of having served with a combat arm. Taking as his subject "What's New in Ordnance," General Schomburg emphasized the Ordnance Corps' dependence upon ideas. He cited the Ordnance Qualitative Development Requirements Information (QDRI) Program, initiated a year ago, as an example of the continuing effort which the Corps is making to stimulate new ideas having a military application.

In developing his theme, General Schomburg presented films and slides which illustrated new ideas in the research stage, as well as some which have become operational. These included a new tank mine, a promising air-suspension system for ground vehicles, and a night-vision device for tank crews which was used successfully on the submarine SKATE in its subpolar voyage.

Other illustrations consisted of developments in the damaging power of bullets, the effectiveness of the Hawk ground-to-air missile system, and several examples of microminiaturization. These last included a lamp so small that it could be passed through the eye of a needle.

Others seated at the head table were: Col. L. W. Stearns, program chairman and a director, New York Post; Capt. W. A. Smith, U.S.N., U. S. Naval Supply Depot; H. W. Barclay, vice-president, New York Post; H. H. Rogge, regional vice-president, National Security Industrial Association; Chester Mueller, vice-president, New York Post; Col. E. H. Kibler, Ordnance Officer, First U. S. Army; Howard E. Isham, first vice-president, New York Post; Brig. Gen. Kenneth Stiles, Air Force Reserve, director, New York Post; Brig. Gen J. M. Chappel, U.S.A.F., Deputy Chief of Staff, Operations, CONARC; Maj. Gen. R. G. Butler, commanding general, Ordnance Special Weapons-Ammunition Command.

Also H. T. Luria, vice-president and director, A.O.A.; Maj. Gen. R. W. Curtis, commanding general, II Army Corps (Reserve); W. L. O'Donovan, director, New York Post; Col. C. F. Buck, commanding officer, Picatinny Arsenal; A. E. Van Cleve, third vice-president, New York Post; Comdr. A. W. Nordquist, assistant supervising inspector of naval material; J. J. O'Neill, president, Empire Post, A.O.A.; Col. H. G. Jepson, secretary-treasurer, New York Post.

An especially impressive feature of the dinner meeting was the invocation written and delivered by Howard E. Isham, a vice-president of the Post and vice-president and treasurer of United States Steel Corporation. We quote this beautiful prayer in full:

"Our Father and our God, we live this night in a world of even greater uncertainty than we did when we last met a year ago. A world where the lust of men for personal power and greed casts a bleak shadow upon the lives of the peace-loving peoples of the world.

"We are thankful that our Nation is truly dedicated to the establishment of a peaceful world. We pray, however, that we do not live merely within ourselves but that we assume our greater responsibilities in protecting the weak and defenseless against the ruthless aggressor.

Maj. Gen. R. G. Butler, Ordnance Special Weapons-Ammunition Command, center, reads Army's Certificate of Appreciation awarded to Col. Edward F. McCrossin, chief, New York Ordnance District, right. Col. Leo A. Codd, A.O.A. executive vice-president, left; Maj. Gen. August Schomburg, Deputy Chief of Ordnance; and Lieut. Gen. L. R. Groves, New York Post president, seated at right, look on.

Wilt Thou keep us ever aware and alert against the forces of evil.

"We pray that Thou will gird us with Thy armor of righteousness as we face the trying problems of today and those in the days ahead. Help us to be humble and understanding in all things.

"In this critical hour of the world's history we mourn the passing into the great beyond of a great figure who devoted the later years of his life to the attainment of the goal of peace, but with justice—John Foster Dulles. May his influence continue to be great in the years to come."

Commodity And Technical Support Divisions Report Full Program Of Meetings

Increased activity and effectiveness have marked the progress of the Technical Divisions during the first six months of 1959. Both Commodity and Technical Support Divisions have held full-scale meetings and entered on major programs of study.

The following six Commodity Divisions have held full Division meetings: Missiles and Astronautics Division, March 17th-19th; Underwater Ordnance Division, April 29th-May 1st; Combat and Tactical Vehicle Division, May 14th-15th; Electronics Division, May 18th-20th; Small Arms and Small Arms Ammunition Division, June 2nd-3rd; Artillery Division, June 11th.

During this same six months there also has been progress and activity in the Technical Support Divisions. Two Divisions have held meetings—Standards and Metrology Division on January 14th-15th and Packaging and Handling Division on May 26th-27th.

Within the Technical Support Divisions, the Production Techniques Division has formed two new Sections which have held their initial meetings—Castings Section and Drafting Section.

The Powder Metallurgy Section of the Materials Division has increased its size and activity and the Research Division is in the process of recruiting outstanding scientists to serve in its Sections.

Well-planned programs and excellent locations have contributed to the general quality of these meetings. Increased effectiveness in support of defense agencies has marked the progress of A.O.A. technical operations.

Experience from past operations demonstrates the value of advance preparation for Division and Section meetings. After Government agencies have indicated problem areas within their specific field, the chairman and program manager can select the area around which the Section or Division meeting can be planned most effectively.

After Government and industry personnel have prepared papers to give adequate background for the full comprehension of the problem, specific individuals should be designated to discuss possible approaches to the preparation of reports and recommendations looking toward its solution.

Adequate meeting time also should be allowed for discussion of problems and reports by Division executive boards and steering committees. When these reports have been substantially agreed upon, they should be forwarded as indicated in the last paragraph on page 14 of the Technical Operations Manual.

Electronics Division Holds Two-Day Meeting At Asbury And Ft. Monmouth

Dr. George L. Haller, General Electric Company, Syracuse, N. Y., chairman, opened the meeting of the Electronics Division on May 18th-19th at the Berkeley-Carteret Hotel in Asbury Park, N. J. Meetings also were held at the U. S. Army Signal Research and Development Laboratories, Fort Monmouth, N. J.

After individual Section meetings, conferees joined to hear Dr. S. W. Herwald, Westinghouse Electric Corporation, Pittsburgh, Pa., discuss "Automation in Russia." His talk covered industrial and technical Russia and explained the adoption of an incentive system in Russian industry. He further discussed Soviet factory facilities, working conditions, and other facets of the workingman's life.

A full schedule of technical meetings was on the program for the second day. As presented by Fort Monmouth personnel the topics were: "Parts and Materials for the New Electronics," Col. L. D. Rouge, director of the Electronic Computing Department; "Use of General-Purpose Field Data Family of Computers in the Field Army," Capt. W. F. Luebbert, chief, Data Equipment Branch, Communications Department; "Combat Surveillance," T. Maloney, J. McCue, and F. Haake, Surveillance Department; "Micromodules—Practical Approach to Microminiaturization," A. W. Rogers, Electronic Components and Research Department; "Electronic Support of Surveillance Drones for Army Aviation," Capt. F. Petty, Avionics Division, Surveillance Department.

Immediately following luncheon, Division members embarked to the site of the Diana project of the Astro-Electronics Division of the U. S. Army Signal Research and Development Laboratories where they toured the facilities and received a briefing on the specific work of that division. Diana is a complex of transmission equipment, a 50-foot reflector, and data-processing equipment used in space probes and in tracking earth-girdling satellites.

M. D. Lockwood, Sperry Gyroscope Company, center, reports on Ground and Shipborne Section at Electronics Division meeting. Dr. George L. Haller, General Electric Company, Division chairman, is at left and Henry Handler, OCO, is at right.

Middle Tennessee Chapter Inaugurated As Volunteer Post At Gala Meeting

The Middle Tennessee Chapter of the Cincinnati Post was inaugurated as the Volunteer Post at a gala meeting on Friday, May 22nd, at the Belle Meade Country Club, Nashville, Tenn.

Chairman F. Donald Hart opened the meeting by requesting that Maclin Davis, president, Tennessee Foundry & Machine Company, give the invocation. The chairman then introduced the guests seated at the speakers' table who included: Edward C. Wagner, Sperry Farragut Company, Division of Sperry Rand Corporation, Bristol, Tenn.; Col. W. A. Davis, commanding officer, Birmingham Ordnance District, Birmingham, Ala.; Lawrence C. Pace, Pace Corporation, Memphis, Tenn.; Lieut. Col. Van D. Nunnally, Assistant Adjutant General, Tennessee National Guard; Neil Cargile, Allen Products, Inc., Nashville, Tenn.; Verne O. Kyle, Murray Manufacturing Company, Murray, Ky.; Brig. Gen. H. A. Nisley, Warren Paint & Color Company, Nashville, Tenn.; Maj. Gen. Troup Miller, commanding general, Arnold Engineering Development Center, Tullahoma, Tenn.

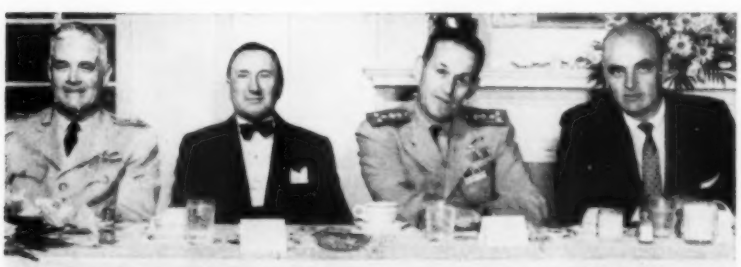
The chairman also introduced the following guests from the floor: Capt. Thomas K. Wright, U.S.N., commanding officer, Naval R.O.T.C., Vanderbilt University; Johnathan J. Foley, Jr., president, Navy League; Thomas Kennedy, president, Nashville Chamber of Commerce.

Capt. J. M. P. Wright, from American Ordnance Association Headquarters, spoke briefly on the organization and the purpose of the A.O.A. and the growth of the society since it was founded forty years ago. He complimented the Middle Tennessee Chapter on its enthusiastic growth during the past two years and presented the chairman with the charter which advanced this Chapter to Post status, covering an area extending from Memphis to Bristol.

As the next order of business, Granville Bourne, chairman of the nominating committee, placed in nomination the following slate of officers and directors who were unanimously elected: president, F. Donald Hart, Temco, Inc., Nashville; first vice-president, Neil H. Cargile, Allen Products, Inc., Nashville; vice-president, Lawrence C. Pace, Pace Corporation, Memphis; vice-president, Freeman G. Cross, Fulton Sylphon Division, Robertshaw-Fulton Controls Company, Knoxville; vice-president, Brig. Gen. H. A. Nisley, Warren Paint & Color Company, Nashville; secretary-treasurer, Dempsey Weaver, Buell & Crockett, Nashville.

The following directors also were elected: A. Paul Brown, Westinghouse Electric Corporation, Nashville; A. O. Burton, Hunter Division, Robbins & Myers, Inc., Memphis; Bernard A. McDermott, Ferro Corporation, Nashville; Edward C. Wagner, Sperry Farragut Company, Division of Sperry Rand Corporation, Bristol; Edwin A. Keeble, Edwin A. Keeble Associates, Inc., Nashville; Shepard Schwartz, May Hosiery Mills, Nashville; Wesley H. Dyer, Metal Products Company, Nashville; Verne O. Kyle, Murray Manufacturing Company, Murray, Ky.; Capt. Thomas K. Wright, U.S.N., commanding officer, Naval R.O.T.C., Vanderbilt University; Granville B. Bourne, Third National Bank, Nashville; James G. Stahlman, *Nashville Banner*; Col. Gilbert M. Dorland, Nashville Bridge Company.

Capt. James G. Stahlman, U.S.N.R., publisher of the *Nashville Banner*, introduced the principal speaker, Vice Adm. John T. Hayward, Deputy Chief of Naval Operations for Development, Washington, D. C.



At Volunteer Post inaugural dinner were, left to right: Maj. Gen. Troup Miller, commanding general, Arnold Engineering Development Center; Maclin Davis, Tennessee Foundry & Machine Company; Vice Adm. J. T. Hayward, Deputy Chief of Naval Operations, principal speaker; F. Donald Hart, Post president.

Admiral Hayward delivered a most interesting address entitled: "The Navy's Polaris Underwater Missile System." The Polaris, he explained, is a 1,500-mile-range atomic rocket which may be fired from a submarine while submerged. The Polaris is vitally important since the submarine can move about and provides flexibility. We must have this system, he said, so that the Russian planners will know that if they destroy one system, there will be others left to destroy them. Considerable emphasis was placed upon the serious challenge offered by Russia's development in many fields during the past forty years. He concluded that the desire and spirit to remain free will win against the challenge of Communism.

Dr. Charles S. Draper Addresses Meeting Of The Capital Cities Post

The Capital Cities Post completed the 1958-1959 season on Thursday, May 7th, with its third and most heavily attended meeting. Crooked Lake Inn was selected as the meeting site, half-way between Pittsfield, Mass., and Schenectady, N. Y., so that members in western Massachusetts could be present.

Dr. Charles S. Draper, head of the Department of Aeronautical Engineering, Massachusetts Institute of Technology, the guest speaker, was introduced by Raymond C. Berendson, manager of guidance and control at General Electric Company's Pittsfield plant.

Prior to the main event, Post President Arthur B. Gregg made a brief business report and introduced the guests. He announced the names of the cadets who had won the Capital Cities R.O.T.C. awards at Rensselaer Polytechnic Institute and Siena College. The cadets received their certificates at presentation ceremonies on their college campuses later in the month.

At the conclusion of the meeting the new officers and directors were installed and the gavel passed to Ross L. Fryer, a vice-president of Alco Products, Inc., the new Post president. Col. W. M. Tisdale, commanding officer of Watervliet Arsenal, remains as first vice-president, and William Stuart, Watervliet Arsenal, is now second vice-president. The directors whose terms had expired were reelected.

Dr. Draper's talk on "Flight Vehicle Guidance" was made doubly interesting by his use of excellent slides and much appropriate humor.

After a rapid review of the growth of flight, Dr. Draper outlined the guidance techniques now in use and expanded his

remarks into predictions on future vehicles such as Mach 3.5 jets, rocket ships, and vertical take-off aircraft. He noted that inertial guidance, his own specialty, was the only possible means of controlling missiles fired from submerged submarines.

He pointed out that great improvement in control of the airlanes was not only essential but feasible in the present state of the art.

Packaging And Handling Division Meets At Quartermaster Command

The Packaging and Handling Division held its annual meeting on May 26th-27th at the Quartermaster Research and Engineering Command, Natick, Mass. Chairman John W. Kraus, Thompson Ramo Wooldridge Inc., Cleveland, Ohio, opened the meeting with an explanation of Division objectives as related to assisting the military services maintain a high level of preparedness.

After Col. Hoke Wofford, deputy commander, Quartermaster Research and Engineering Command, Natick, Mass., welcomed the conferees, Mr. Kraus introduced Ralph O'Reilly, General Motors Corporation, Detroit, Mich., as Division deputy chairman.

Mr. O'Reilly conducted the afternoon technical session in which representatives from the three military services and from industry related new developments and problem areas within their own fields. Research activities at the Quartermaster Research and Engineering Command, Natick, Mass., were outlined by Dr. J. Fred Oesterling. These activities range from footwear for extreme climatic conditions to overland conveyor systems for movement of military support material.

Lieut. Col. George Davies, Headquarters, United States Air Force, Washington, D. C., cited the need for advanced thinking and coordination of efforts for the development of an integrated air cargo system. Representing the Army was Paul A. Fons, Transportability Office, Huntsville, Ala. He stated that continual emphasis is placed on developing missile transporters whose weight is less than the items carried.

Joseph Kay, Bureau of Ordnance, United States Navy, Washington, D. C., described some of the problems encountered in the packaging and handling of missiles, specifically the Terrier and the Tartar.

Industry's spokesman was William L. Newman, General Electric Company, Syracuse, N. Y. Mr. Newman spoke on the need for more direct lines of communication between industry and the military in an effort to reach full cooperation.

On May 27th, each of the Division's four Sections met separately to formulate programs of action based on problems presented the preceding day.

A final technical session consisted of a talk given by Lieut. Col. M. E. Peterson, Air Research and Development Command, Washington, D. C., on Air Force plans for an integrated material-handling system followed by reports by the Section chairman summarizing the activities of the respective meetings.

The 2-day meeting closed with a tour of the Natick facilities. Of particular interest were the many special pieces of equipment designed for the movement of material and equipment over rough terrain. Also on display was a solar furnace which can reach ultrahigh temperatures by concentrating the sun's rays in a confined area through the use of mirrors.

Attending Packaging and Handling Division meeting were, l. to r.: Ralph O'Reilly, GMC; Maj. Gen. E. P. Mechling, A.O.A. staff; Lieut. Col. George Davies, U.S.A.F.; J. W. Kraus, Thompson Ramo Wooldridge Inc.; W. L. Newman, General Electric Company; P. A. Fons, Huntsville, Ala.; and Joseph Kay, Navy Bureau of Ordnance.

Metal Working Lubricants Section Meets At Naval Research Laboratory, D. C.

Chairman George Gleim, Esso Standard Oil Company, New York, N. Y., presided over a meeting of the Metal Working Lubricants Section of the Production Techniques Division on May 12th at the Naval Research Laboratory, Washington, D. C.

Henry N. Marsh, A.O.A. vice-president for technical divisions, and Maj. Gen. Edward P. Mechling, A.O.A. staff director for technical operations, addressed the meeting on the recent reorganization of the Technical Divisions to conform with the Technical Operations Manual.

Part of the change includes the establishment of a Section steering committee. Those appointed to membership on this committee were: Dr. M. E. Merchant, Cincinnati Milling Machine Company, Cincinnati, Ohio; J. W. Miller, Remington Arms Company, Ilion, N. Y.; F. J. Schmitt, D. A. Stuart Oil Company, Brooklyn, N. Y.

As a result of Section work, a specification on soluble cutting oil will be submitted to the office of the Chief of Army Ordnance for assignment of a military specification number. Members discussed the need for a review of specifications dealing with lubricants, and Mr. Gleim appointed a subsection which will compile all existing Government specifications on the subject into two categories—active and inactive.

Another subsection will be formed to discover which metalworking operations used in Government facilities are similar to those of industry. One section member also will survey available foreign publications on the subject of metalworking lubricants, especially those dealing with cold extrusion.

Two papers were presented by representatives of the Naval Research Labora-

tory in Washington, D. C.: "The Lubricating Properties of Monomolecular Films Adsorbed on Solid Surfaces," Dr. W. A. Zisman, Chemistry Division, and "Relations of Chemical Constitution to the Wetting and Spreading of Liquids on Solids," Mrs. E. G. Shafrin, Surface Chemistry Branch.

Following lunch, Section members, consultants, and guests were taken on a guided tour of the extensive Naval research facilities.

Artillery Division Hears Technical Papers During Meeting At Watervliet

Watervliet Arsenal, Watervliet, N. Y., was the scene of a meeting of the Artillery Division on June 11th. Acting Chairman J. L. Cohill, Firestone Tire & Rubber Company, Akron, Ohio, substituted for Division Chairman J. E. Trainer, also of Firestone Tire & Rubber Company, and introduced the commanding officer of Watervliet Arsenal, Col. W. M. Tisdale.

Everett L. Baugh, Cadillac Motor Car Division, Cleveland Ordnance Plant, GMC, Cleveland, Ohio, general chairman of the Technical Divisions, also addressed the gathering.

Mr. Cohill outlined the technical program of the meeting which consisted of progress reports on the programs for Vigilante, Moritzer, the spigot-type recoilless rifle, and Little John by representatives of the Ordnance Weapons Command and Frankford Arsenal. As a new Division function, representatives of Ordnance installations presented specific problems encountered in their work to the Division as a group and opened the floor for discussion. After the meeting these problems were collected and distributed to the appropriate Divisions and Sections for study and action. Thus, the best thinking of ordnance and industry is employed for the solution of mutual technical problems.

George E. McNeil, Jr., Ordnance Weapons Command, Rock Island, Ill., gave the first talk accompanied by motion pictures of tests associated with such projects as Vigilante, Moritzer, and Little John. As a supplement, Brig. Gen. William K. Ghormley, commanding general, Ordnance Weapons Command, Rock Island, Ill., outlined certain problems encountered by his command on these and other related programs.

Representing Frankford Arsenal, Philadelphia, Pa., was Col. G. T. Peterson, who described the classified work at Frankford on fire control for Vigilante and on the spigot-type recoilless rifle. Colonel Peterson also listed some of the problems encountered while working at Frankford.

Some new artillery concepts for the future were presented by A. Muzicka, Watervliet Arsenal. Colonel Tisdale then discussed specific technical problems which arise from the stringent requirements of the new concepts as well as probems of a more general nature.

In describing the working of the Qualitative Development Requirements Information Program at the Ordnance Weapons Command, Mr. McNeil explained that these requirements were being prepared by the various arsenals and were being released to qualified and interested industrial groups who would in turn submit voluntary proposed solutions. These solutions would then serve as a means of bringing together industry-Ordnance teams to solve technical problems.

The morning session ended with a discussion by Thomas Davidson, Watervliet Arsenal, on artillery-fabrication techniques leading to higher-strength, lighter gun tubes and the fundamental studies on gun-fabrication methods in progress at Watervliet.

The afternoon session began with a question-and-answer period presided over by those who had made presentations in the morning. Solutions to some of the specific problems covered in the morning were given and others will be given further study.

V. E. Lucas, Firestone Tire & Rubber Company, Akron, Ohio, who is secretary of the Division, reported that the former Committees had been renamed Sections according to the stipulations of the Technical Operations Manual and that the Gun Forging Committee is now known as the Gun Tube Section. The general session closed with a meeting summary by Mr. Cohill, followed by a conducted tour through the facilities of Watervliet Arsenal.

An executive board meeting followed the general session, and it was resolved that each Section be organized to include a chairman, deputy chairman, and secretary in order to function more effectively.

The next Division meeting will be held within the year at Frankford Arsenal, Philadelphia, Pa., and will include a report on all the items presented at the current meeting to preserve continuity in the problems and presentations.

It was decided that carefully planned and topical programs will make future meetings more attractive and that this approach to program planning could be the activating influence in the revitalization of all of Divisions and Sections.

Industry and Department of Defense representatives at Artillery Division meeting.

Small Arms And Ammunition Units Hold Two-Day Meeting At Aberdeen Proving Ground

A meeting of the executive board of the Small Arms and Small Arms Ammunition Division preceded a meeting of the Division on June 2nd and 3rd at Aberdeen Proving Ground, Md. Chairman Maxwell R. Warden, Remington Arms Company, Bridgeport, Conn., presided.

Col. Gilbert P. Dubia, Aberdeen Proving Ground, welcomed the executive board and introduced Maj. Gen. Holger N. Toftoy, commanding general of Aberdeen. General Toftoy reaffirmed the desire of the proving ground to maintain a close working relationship with industrial representatives.

Mr. Warden introduced three Army Ordnance Corps representatives who presented a summary of problems offered to this Division for their assistance. Members then joined in an open discussion of ways to improve communication between

the Ordnance Corps and the Technical Divisions and Sections of the American Ordnance Association. It was decided that "the keystone of all successful co-

Maj. Gen. J. H. Hinrichs, Chief of Army Ordnance, left; M. R. Warden, Remington Arms Company; and Maj. Gen. H. N. Toftoy, commanding general, Aberdeen Proving Ground, right, examine an M14 rifle.

operative effort between Government installations and the A.O.A. Divisions is, and will remain, a close working relationship between individuals."

Problems submitted to the Association will fall into three general categories which will require three separate methods of handling: specific technical problems with no extended implications which may be handled across the table; technical questions with broader implications which may be reviewed by the appropriate Section and answered formally after review; and questions affecting policy which are answered by the Section and transmitted through A.O.A. headquarters to permit policy coordination.

The Division meeting was opened formally by Maj. Gen. John H. Hinrichs, Chief of Army Ordnance, who stressed the dependence of the Ordnance Corps on the continued cooperation of industry. More than one hundred representatives of industry and the armed forces attended the meeting to discuss recent developments and future Army requirements for small arms and small-arms ammunition.

First speaker of the afternoon session was Laurence Moore, Aberdeen Proving Ground, who described and explained the types of tests which are performed on a typical small-arms item, the M14 light automatic rifle. The tests included examination, disassembly and assembly, accuracy, endurance, extreme cold, dust, mud, rain, and cook-off.

The second part of the demonstration consisted of the firing of a number of new and experimental ordnance items with particular emphasis on the relative capability of new weapons compared with conventional small arms. The third part of the demonstration included tests of vehicles to demonstrate the kinds of tests which are performed to ensure that vehicles will be able to operate under the adverse conditions which may be encountered in the field.

Members assembled in the evening at the Officers' Open Mess to hear General Toftoy discuss the operation leading to the selection and transfer to the United States of the leading German scientists who later formed a nucleus for the Army's missile-development team.

The meeting resumed on the morning of June 3rd with the following technical presentations: "Recent Developments in Small Arms Ammunition," Charles M. Dickey, Frankford Arsenal, Philadelphia, Pa.; "Ballistic Research Laboratory Activity Related to Infantry and Aircraft Weapons Systems," Donald Hall and Morgan Smith, Ballistic Research Laboratory, Aberdeen Proving Ground, Md.; "Recent Developments in the Small Arms Weapons Field," George McNeil, Jr., Ordnance Weapons Command, Rock Island, Ill.

The meeting closed with a presentation by Col. George T. Metcalf, Continental Army Command, Fort Monroe, Va., on "Future Infantry Concepts."

Walsh, Blandy, And Goddard Memorial Awards Presented To Outstanding Students

The Association's James L. Walsh Memorial Award was presented this year to Cadet Donald R. Reinhard who led his class at the U. S. Military Academy in Ordnance. The award, a Winchester sporting rifle, was presented by Col. John C. Raaen, Ordnance Corps, United States Army (Ret.), long a member of the Association, at June Week ceremonies on the Plain at West Point. Cadet Reinhard, from Miami, Fla., was commissioned a 2nd lieutenant of Artillery, and his first assignment is a Fort Sill, Okla.

The W. H. P. Blandy Memorial Award was won by Midshipman John T. Lawler who was outstanding in practical ordnance and gunnery. The presentation was made at the Naval Academy by Vice.

Vice Adm. G. F. Hussey, Jr., A.O.A. director, presents the W. H. P. Blandy Memorial Award to Midshipman J. T. Lawler during ceremonies at U. S. Naval Academy.

The American Ordnance Association policy is to encourage its members who are active in defense technology to apply for membership in the Technical Sections for which they are qualified.

In addition to A.O.A. membership and the requisite technical qualifications, applicants for membership in the Technical Sections should have a current security clearance of "secret" granted by one of the Defense agencies through their own companies. Details of the objectives, organization, scope, and operations of the Technical Divisions are contained in the A.O.A. Technical Operations Manual.

Interested members can obtain a directory, Technical Operations Manual, and Section membership forms by requesting them from A.O.A. headquarters. Applications should be sent to American Ordnance Association, Mills Building, Washington 6, D. C.

Adm. George F. Hussey, Jr., a director and former president of the Association, Midshipman Lawler, of Longview, Wash., was commissioned an ensign, U.S.N., and has been assigned to basic flight training at Pensacola, Fla.

The newly established Robert H. Goddard Memorial Award presentation at the Air Force Academy was announced in the July-August issue of ORDNANCE. Cadet Brock T. Strom, top man in mathematics, received his prize from Gen. B. W. Chidlaw, past president of the Association.

Combat Vehicle Group Discusses Reliability At Meeting In Detroit, Mich.

With "Reliability" as a general theme, industry joined representatives of the Department of Defense at a meeting of the Combat and Tactical Vehicle Division at the Rackham Memorial Building in Detroit, Mich., on May 14th-15th. Chairman Chester C. Utz, Chrysler Corporation, Detroit, Mich., presided.

The entire meeting was aimed directly at the subject of improved reliability and reduced field maintenance of combat and tactical vehicles. In an opening address, Maj. Gen. Nelson M. Lynde, Jr., commanding general, Ordnance Tank-Automotive Command, Detroit, Mich., stated that future wars will require a degree of mobility beyond anything previously attained.

The keynote civilian address was given

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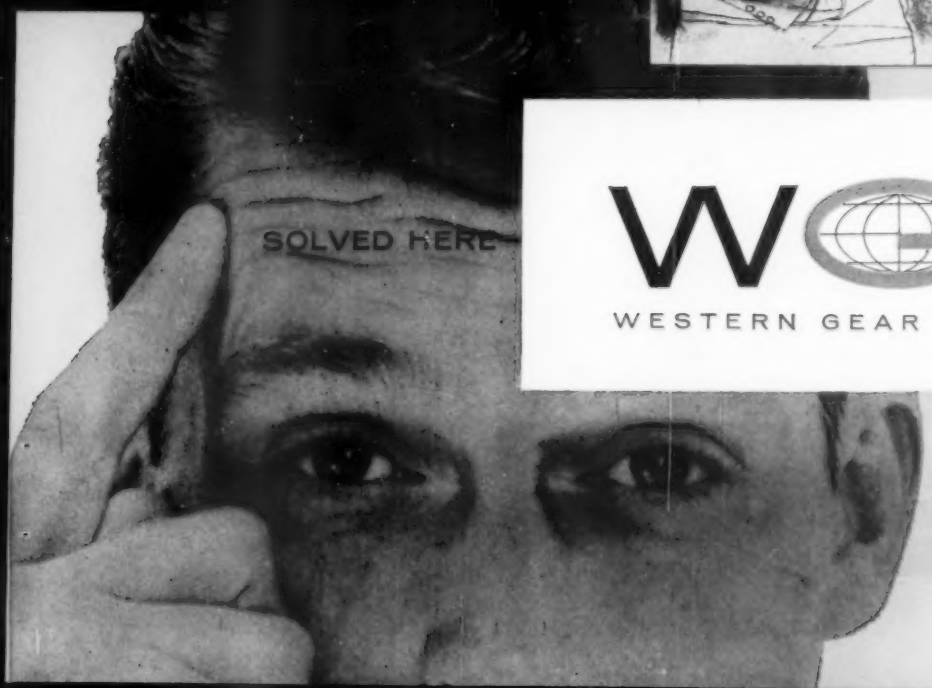

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FOR 25 YEARS THE LEADING MANUFACTURER OF CORROSION CONTROL PRODUCTS

by Arch T. Colwell, Thompson Ramo Woodridge Inc., Cleveland, Ohio. He pointed out that new styles in vehicles do not mean better reliability because industry rarely brings out a vehicle having all new components.

Under the topic "What can be done to improve reliability and reduce maintenance?" conferees watched a movie entitled "The Military Environment" and heard the following technical papers: "Guide Lines for Trucks," by Robert C. Wallace, Diamond T Motor Truck Division, Chicago, Ill.; "Guide Lines for Combat Vehicles," by James M. Heyne, Cleveland Ordnance Plant, Cadillac Motor Car Division, GMC, Cleveland, Ohio; "Guide Lines from the Military Viewpoint," by Col. W. G. Merriam, Combat Vehicles Division, Continental Army Command, Fort Monroe, Va.

Three speakers discussed the various aspects of engines: "Combat Engines," Carl F. Bachle, Continental Aviation and Engineering Corporation, Detroit, Mich.; "Truck Engines," Robert Stevenson, Jr., Ford Motor Company, Detroit, Mich.; "Engines from the Military Viewpoint," Capt. R. H. Sawyer, Ordnance Tank-Automotive Command, Detroit, Mich. Topics and speakers on transmissions were: "Tracked Vehicle Transmissions," Hugh C. Kirtland, Allison Division, General Motors Corporation, Detroit, Mich.; "Tactical Vehicle Transmissions," Robert R. Burkhalter, Dana Corporation, Toledo, Ohio; "Transmissions from the Military Viewpoint," Edward F. Blackburne, Ordnance Tank-Automotive Command, Detroit, Mich.

Three papers were given on "Chassis Components": "Suspension and Mobility," by Dale B. McCormick, Vehicle Development Group, GMC, Detroit, Mich.; "Drivelines and Axles," N. R. Brownyer, Rockwell Standard Corporation, Detroit, Mich.; "Chassis Components from the Military Viewpoint," Joseph B. Hayes, Ordnance Tank-Automotive Command, Detroit, Mich. Following the reading of the papers, Mr. Wallace and Mr. Heyne led the conferees in open discussion.

The program for the first day ended with a banquet at the Park Shelton Hotel. Dr. William B. McLean, Technical Director, Naval Ordnance Test Station, China Lake, Calif., spoke on "Research and Development in Naval Ordnance."

Mr. Utz, Division chairman, and A. A. Parquette, Ford Motor Company, Dearborn, Mich., deputy chairman of the Division, began the activities on May 15th with a discussion of "The Ideal Tactical Military Vehicle." Dr. C. G. A. Rosen, consultant, Detroit, Mich., spoke on "The Changing Aspect of Field Maintenance." A military discussion was presented by Col. James R. Pritchard, U. S. Army Maintenance Board, Fort Knox, Ky.

The subject, "Field Data for product Reliability," was outlined by Dr. P. W. Lett, Chrysler Corporation, Detroit, Mich. A military discussion by Edward C. Slayman, Ordnance Tank-Automotive Command, Detroit, Mich., ended the morning technical session.

"Corrosion Prevention, Storage, and Preservation of Military Vehicles" was presented by A. R. Black, Shell Oil Company, New York, N. Y. Discussions from both the military and industrial point of view were given by Clare L. McDermit, Ordnance Tank-Automotive Command, Detroit, Mich., and I. E. Parsons, Jr., Continental Motors Corporation, Muskegon, Mich.

Errol J. Gay, consultant, Detroit, Mich., presented "Driver Training and Attitude —Its Effect on Vehicle Life" which was followed by a military discussion by Col. W. A. Hamberg, United States Continental Army Command, Fort Monroe, Va.

The meeting closed with remarks by representatives from both industry and the Government. A report of the recommendations made at this meeting is covered on page 342 of this issue.

Test Range Instrumentation Section Holds Two-Day Meeting At Eglin AFB

A 2-day meeting of the Test Range Instrumentation Section of the Fire Control Instrument Division was held at Eglin Air Force Base, Fla., on May 18th-19th. Dr. C. W. Miller, Perkin-Elmer Corporation, Norwalk, Conn., Section chairman, conducted the meeting.

A welcoming address by Maj. Gen. Joe W. Kelly, commanding general, Eglin Air Force Base, opened the technical session which continued with a technical presentation by the personnel of Eglin. Conferees then toured part of the Air Force base facilities which included the data-reduction center, the central time station, and a Bomarc launching site.

On the second day, conferees divided into three groups to discuss optical instrumentation, data reduction, and electronic problems. Each of the problems for discussion within the panels was presented by Eglin personnel, and detailed discussion of the problem followed each of the presentations. The technical session closed with a summary by each of the panel chairmen on the discussion and recommendations of the individual groups. This was presented to all those who attended.

Chairman of the Optical Instrumentation panel was Carl Schiefner, Instrument Corporation of Florida, Melbourne, Fla., who worked with W. J. McGraw,

Avco and a Modern Minuteman—Recent work at Avco led to a solution of the missile re-entry problem, and to production of the nose cone for the Air Force Titan ICBM. Now the Air Force announces a development program for Minuteman, a solid fuel missile that will be capable of instantaneous firing with no preparatory fueling delays. Its nose cone, too, will come from Avco's Research and Advanced Development and Lycoming Divisions . . . implementing this modern Minuteman's vigilant defense of our shores.

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coordinator-representative of Eglin Air Force Base.

The following general topics were discussed by panel members: hypervelocity impact photography, optics in range operation, ballistic camera system, and long focal length optical systems. Panelists were W. A. Brown, H. O. Cahalan, and W. F. Mantey.

J. R. Belford, International Business Machines Corporation, Owego, N. Y., assisted by K. V. Woolsey, Eglin Air Force Base, led in a discussion of the panel on data handling. Ballistic camera data handling, impact prediction, and accuracy evaluation of data from space position instrumentation were the subject matter of the second panel. Speakers included, R. H. Bryant, B. P. Burnett, H. H. Strong, J. L. Thoreau, G. E. Weekly, and Lieut. Col. B. Young.

The electronic instrumentation panel was conducted by John J. Hibbert, Bell Telephone Laboratories, Inc., Whippany, N. J., with R. B. Coe, Eglin Air Force Base. Full discussion centered on four topics: atmospheric effects on space-position measurements, calibration and accuracy measurements on tracking radars, proximity scorers for airborne targets, and radar augmenters for airborne targets. K. L. Huntley, F. H. Prestwood, and J. R. Steiner composed the panel.

Quad Cities Post Hears Several Speakers During Rock Island Arsenal Meeting

The spring meeting of the Quad Cities Post held at Rock Island Arsenal on Monday, May 18th, was attended by 120 members. Post President Alex Matheson, the presiding officer, introduced Brig. Gen. W. K. Ghormley, commanding general, Army Ordnance Weapons Command, who welcomed the assembly.

At the business session the new slate of officers presented by M. A. Fraher, chairman of the nominating committee, was accepted unanimously. The new president is A. Linton Lundy, Midwest Metals Corporation, and the vice-president is Victor B. Day, Bear Manufacturing Company.

Mr. Lundy discussed the methods by which the Soviet economic challenge can be met. Then Col. E. M. Fry, Army Corps of Engineers, gave an illustrated talk on recent power-development programs within the Iron Curtain countries. From his descriptions it was evident that the United States should develop its water-power resources to the fullest.

The climax of the evening was an excellent talk by Louis Young, Bendix Aviation Corporation, entitled "Advance Weather Reconnaissance and Forecasting." During the course of the talk the reasons for the observation of weather were cited and the present methods being used and those in prospect were fully discussed. Devices such as the weather satellite were explained and illustrated by slides, and it was pointed out that in Project AN/AQM-15 it was expected the 4 weather squadrons of 30 transports, each, flying 43,000 hours a year, would be used in the near future.

Birmingham Post Launches New Program Activity At Gala Luncheon Meeting

The Birmingham Post launched its new program of increased activity at a luncheon meeting on Thursday, May 14th.

HIGH TEMPERATURE CAPACITORS BY BENDIX

The *E*-315 capacitor offers proven stability of operation over the temperature range of −55° to +315° Centigrade* with no voltage derating and low capacitance variation. Of rugged hermetically sealed construction and nonstrategic materials, this capacitor is built for high altitude and severe environmental operation.

This nonpolarized capacitor is available in a variety of sizes in a capacity range of from 0.05 to 4.0 microfarads at 600 VDC. It is also available in higher voltage ratings. Performance data and operating characteristics are given in Technical Bulletin SL-61 which is supplied upon request.

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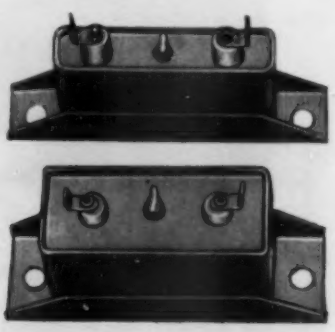

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An unexpectedly large number of members promptly gathered at 12:15 at the Downtown Club in Birmingham, Ala., to meet Col. Calvin A. Heath, chief, Industrial Division, Army Ballistic Missile Agency, Huntsville, Ala.

Colonel Heath showed a film entitled "Probe into Space" that portrayed the development, testing, and launchings that were involved in the Army's Pioneer space probes. The colonel also discussed many interesting highlights of the project and noted the numerous industrial and governmental activities that had a part in the development.

Some of the distinguished guests present were: Maj. Gen. Walter J. Hanna, senior commander, Alabama National Guard; Capt. G. W. Molesworth, U.S.N., inspector of naval material, Atlanta, Ga.; Merrill Pratt, chairman, Continental Gin Company, Birmingham; Col. W. A. Davis, commanding officer, Birmingham Ordnance District; Arthur V. Wiebel, president TCI Division, U. S. Steel Corporation; Richard M. Donahue, Line Material Company, Southern Division, McGraw Edison Company.

Post President A. B. Schwarzkopf was so pleased with the response to the Post's first semitechnical session that he announced that such meetings would become part of the regular program.

General Stubbs Discusses Chemical Warfare At Final Meeting Of Washington Post

The Washington Post closed one of its most successful seasons at a luncheon meeting on Thursday, May 21st. Post President Ernest A. Tupper introduced the distinguished guests and called on J. K. Hampton, Detroit Diesel Engine Division, GMC, for the report of the nominating committee. The following officers were nominated and elected: Stewart L. Magee, U. S. Steel Corporation, president; M. C. Richmond, Western Electric Company, and W. K. Haines, H. K. Porter Company, Inc., vice-presidents; and Wilbur J. Reed, Westinghouse Electric Corporation, secretary-treasurer.

The guest speaker was Maj. Gen. Marshall Stubbs, Chief of the Army's Chemical Corps, who discussed the need to eliminate the false attitudes toward chemical warfare and the steps that must be taken to put it in the proper perspective. He pointed out that chemical and biological agents can be delivered by the same bombs and missiles that carry nuclear warheads, thus making it urgent that our armed forces be fully prepared to defend against such agents. He also stated the need for a well-advertised offensive capability in order to discourage an enemy from deciding to start using chemical weapons.

General Stubbs told the audience of Soviet capabilities in biological and chemical warfare in order to stress the importance of preparing both our armed forces and our civilian population to understand the nature of such agents and to defend against them.

Others at the speakers' table were: Brig. Gen. Eugene B. LeBailly, Deputy Director of Information Services, U. S. Air Force; Brig. Gen. G. C. Essman, commanding general, Chemical Research and Development Command; Rear Adm. R. K. James, Chief, Navy Bureau of Ships; Maj. Gen. August Schomburg, Deputy Chief of Army Ordnance; Dr. Edwin Paxson, Assistant Director for Technical Weapons, Office of the Director of Defense Research and Engineering; Gen. John E. Hull, president, Manufacturing Chemists' Association.

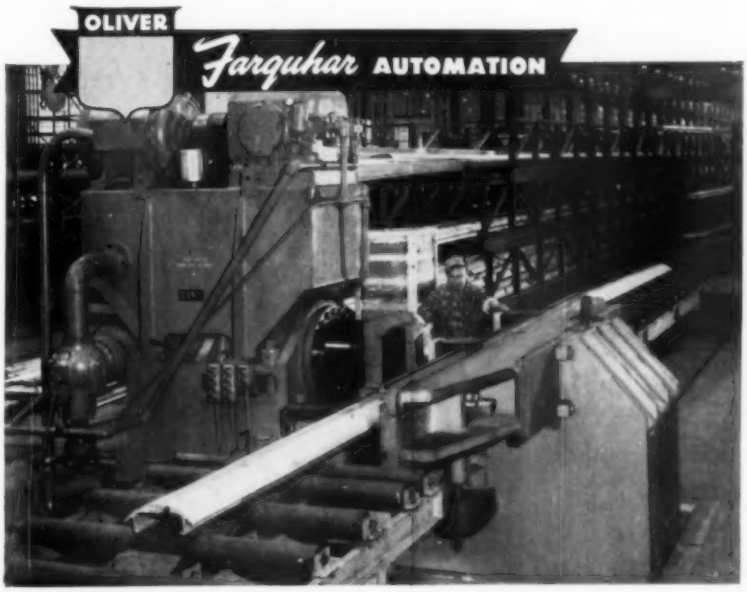
Also, Paul E. Feucht, Deputy Assistant Secretary of the Army (Logistics); John B. Macauley, Deputy Diretor of Defense Research and Engineering; Dr. Howard A. Wilcox, Deputy Director of Defense Research and Engineering; Dr. William H. Martin, Director of Research and Development, Department of the Army; Maj. Gen. Charles E. Loucks, vice-president, Armed Forces Chemical Association.

Also, Maj. Gen. H. R. Paige, Assistant Chief of Staff, Logistics, Headquarters, U. S. Marine Corps; Rear Adm. L. D. Coates, Assistant Chief of Research and Development, Navy Bureau of Aeronautics; Brig. Gen. W. E. R. Sullivan, Deputy Chief Chemical Officer; Col. J. C. Prentice, Deputy Commanding Officer, Biological Warfare Laboratories, Army Chemical Corps; Col. Lloyd Fellenz, Assistant Chief Chemical Officer, Planning and Documents; and Henry Long, outgoing secretary-treasurer, Washington Post, A.O.A.

Steering Committee Of Military Pyrotechnics Section Meets In St. Louis

The newly formed Steering Committee of the Military Pyrotechnics Section of the Bomb, Warhead and Artillery Ammunition Division met for the first time on June 11, 1959. Section Chairman Dr. Herbert Ellern, Universal Match Corporation, St. Louis, Mo., conducted the meeting in St. Louis.

Participants in the meeting were: Sec-



At the U.S. Air Force Heavy Press plant operated by Kaiser Aluminum and Chemical Corporation, Halethorpe, Maryland, Oliver-Farquhar automation specialists designed and built this press-conveyor set up. O-F live-roller conveyors move the aluminum extrusions into the press. The conveyor moves up or down to position the work in the die. Then the ram of the O-F Horizontal Bulldozer Press moves forward to straighten the extrusion. Finally the conveyor moves the work away and the operating cycle starts over again.

This is typical of the automation-minded engineering services incorporating hydraulic or mechanical presses and conveyors that is available only at Oliver-Farquhar. Write, wire or phone for information. The Oliver Corporation, A. B. Farquhar Division, Dept. P-01, York, Pennsylvania.

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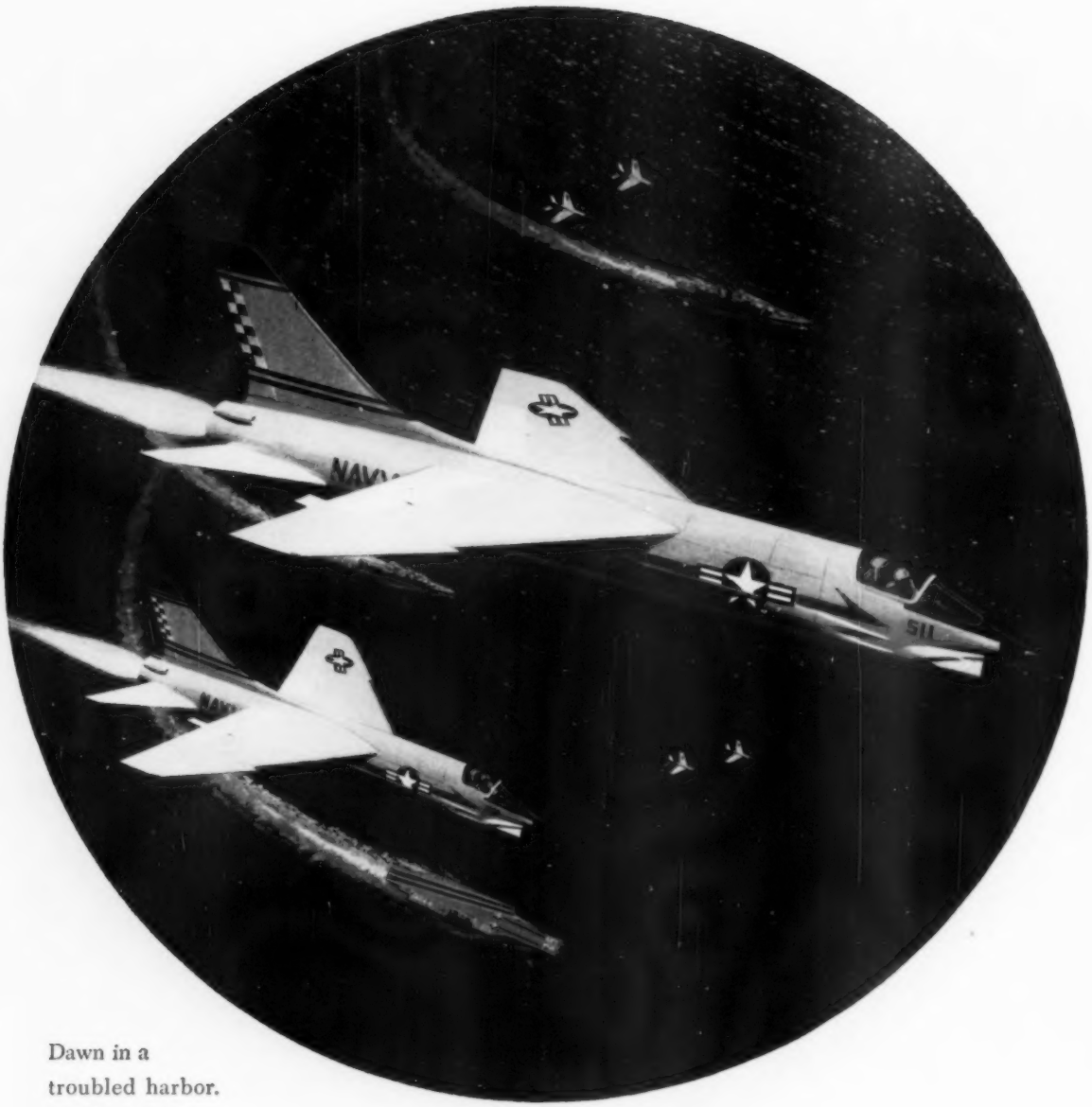

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troubled harbor.
On the horizon,
units of a U. S. Navy
carrier task force.
Yesterday they were 700 miles away.
Today the lean ships and glinting jets are here to back up
U. S. policy. They came equipped to air-land Marines, win air
superiority, or trade nuclear blows.
Few bases are so formidable in so many ways.
None is better suited for guarding the
vast and scattered resources
which form the Free World's strength.

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500TH CRUSADER DELIVERED TO FLEET

The jet fighter that introduced 1,000-plus-mph speed to carrier decks is now with the Navy – 500 strong. Chance Vought *Crusaders* are deployed with the Sixth and Seventh Fleets as day fighters and photoplanes. Another *Crusader* version – the F8U-2N – is being armed and equipped for near-Mach 2 combat in darkness or bad weather. It will join the Fleet next year.

With the *Crusader's* dynamic design, Vought engineers broke down barriers that have stymied carrier aircraft performance. In the same way, the Navy has tuned U. S. carrier design to the changing requirements of defense. Since World War II, these floating bases have been improved 50% in all-weather operation, 100% in aviation fuel capacity and 200% in ammunition storage.

It was a supersonic step forward when these high-performance carriers were joined by the *Crusader*. The transition was completed at low risk and cost. And these fastest of all Navy fighters have since proved reliable, serviceable and economical, too, in long periods of foreign duty that have included Quemoy and Lebanon.

Design and production of high-performance aircraft make up part of the broad spectrum of Chance Vought fields of activity. Other areas include: advanced weapons, astronautics, electronics, anti-submarine warfare, range systems management, commercial process control systems.

CHANCE VOUGHT
DALLAS, TEXAS

tion Vice-Chairman Dr. R. A. Cooley, Chromalloy Corporation, New York, N. Y.; Samuel P. Miller, Universal Match Corporation, Washington, D. C.; Dr. Robert W. Evans, University of Denver, Denver, Colo.; Frank A. Goss, Jr., Sandia Corporation, Albuquerque, N. Mex.; H. H. Hofford, Bureau of Ordnance, United States Navy, Washington, D. C.; Lincoln S. Love, Perry Plastics, Inc., Erie, Pa.; Samuel Page, Picatinny Arsenal, Dover, N. J.

In a discussion of the status of pyrochemical and pyrophysical research, development, and production, conferees decided that although pyrotechnics is not an exact science, it is advancing steadily into the field of high-reliability items. There are a small number of standardized, high-reliability pyrotechnical accessories to missiles and other modern devices but these established devices need frequent adaptation to new and more severe ambient conditions.

Committee members also decided that systems designers often lack state of the art information in pyrochemical devices. The designers' approach to problems of ignition, explosive actuation, spotting charges, special flares, delay timing, destructors, gas cartridges, and heat sources often ignores or underestimates the development, adaptation, and proofing-out of these accessories in their basic planning and time scheduling. This results in the use of not fully proofed-out items, unavailability of time and money for careful development and tailoring of special devices, and the grave danger of malfunction in costly complex weapons because of defects in minor subassemblies.

Members concluded that long-range planning is needed to coordinate basic research in exothermic solid interaction with the general development of standard devices. This will be followed by design of specific hardware and extensive proof production which permits statistically valid functioning tests. This planning is vital not only to create and improve pyrophysical and pyrochemical missile components but also to preserve know-how in industry, arsenals, and universities.

Mr. Love and Mr. Miller will form the nucleus of a subcommittee which will plan a campaign of education and clarification in the field of pyrotechnics.

A full Section meeting will be held on October 7, 1959, at Aberdeen Proving Ground, Md., in connection with the meeting of the Bomb, Warhead and Artillery Ammunition Division. The Section meeting will stress the educational approach with focus on the importance of specific quality control of each item as well as the extent and importance of pyrotechnical accessories in modern weapons.

Puget Sound Post Members Preview Boeing Airplane Company's Production Center

Members of the Puget Sound Post were treated to a preview of the new Boeing Airplane Company Production Center on Friday, June 5th. About 150 members assembled in the company's auditorium where Post Vice-President M. J. Williams conducted a business meeting and K. W. Brown, assistant general manager, Pilotless Aircraft Division of Boeing, welcomed the gathering.

Before dinner the guests viewed the latest production techniques during a tour of the production center. Later, the following three talks were presented by members of the Boeing Airplane Company staff:

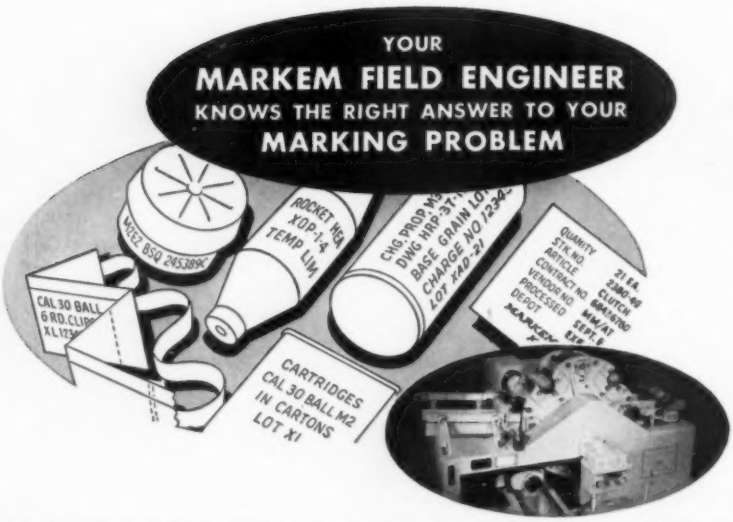
"Past, Present, and Future Space Programs," H. A. Goldie, manager, Dyna-Soar Weapon System Technical Management Branch, Systems Management Office; "Bioscientific Problems in Space Flight," Dr. R. H. Lowry, manager, Space Medicine Branch, Systems Management Office; "What Space Flight Means to You," M. H. Kiehle, chief, Aerodynamics Unit, Pilotless Aircraft Division.

Drafting Section, Production Techniques Division, Holds First Meeting At Washington

The newly formed Drafting Section of the Production Techniques Division held its first meeting on Thursday and Friday, June 11th-12th, at the Army-Navy Club in Washington, D. C. W. W. Thomas, Radio Corporation of America, Moorestown, N. J., Section chairman, presided.

Mr. Thomas explained that the long-term objective of this Section was to give a 2-way channel of communication between military and industry on the subject of drafting. Through the medium of this Section, the military services can benefit from a cross section of industry experience and circulate information regarding new requirements or problems. Industry also will be able to recommend improvements in military practice as recognized by work experience.

The main objectives of this Section as part of the American Ordnance Association were defined by Maj. Gen. Edward P. Mechling, U.S.A.F. (Ret.), staff director for technical operations. The future of the Section, General Mechling said, depends on the viewpoint taken by the Section and its representation of industry as general policy. Thus, the view of the Section must be militarily acceptable. Section meetings must also make industry intimately familiar with their own problems through a highly developed means of interchange.



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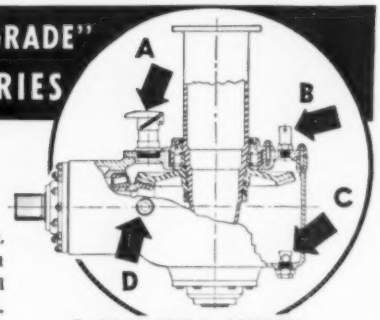
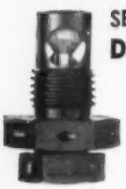


A—FILLER CAPS B—BREATHER VENTS C—DRAIN PLUGS D—OIL SIGHT GLASSES—ALSO LUBRICATION JETS, DRAIN LINES, ETC.



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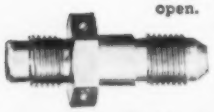

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Association Affairs (Contd.)

General discussion and amplification resulted in the formation of the following subsections: Preparation of Drawings and Lists by EAM Methods; Single Contract Document for All Data Requirements; Drafting for Numerically Controlled Machining; Standardization of the Advance Change Document and Its Uses; Grading Scale for Drawing Quality; Drafting Education Adequacy; Implementation of MIL-D-70327; Implementation of MIL-STD 2, 3, 4; Review of MIL-STD on Machining; Reprocurement for Competitive Bids to Class 2 Drawings; Proprietary Rights Placards; Hardware Detailing; Small Business Drafting Practices; Microfilming; Advanced Developments in the Drafting Art; D.O.D. Documentation Check-off List; and Reidentification of Interchangeable Parts with Provisionable Noninterchangeable Components.

After luncheon representatives from the Department of Defense held a round-table discussion on "The Military Plans for Implementation of MIL-D-70327 into Contract Requirements." Participants were: C. A. Nazian, Frankford Arsenal, Philadelphia, Pa.; J. H. Mars, Navy Bureau of Ordnance, Washington, D. C.; Russell Eaton, Jr., and D. S. Bennett, Air Matériel Command, Wright-Patterson Air Force Base, Ohio; and J. J. Dunn, Armed Forces Supply Center, Washington, D. C. The problems of the implementation and the requirements of this document were discussed fully by the conferees in a free question-and-answer period.

An informal buffet at the Army-Navy Club ended the activities of the first day of the conference.

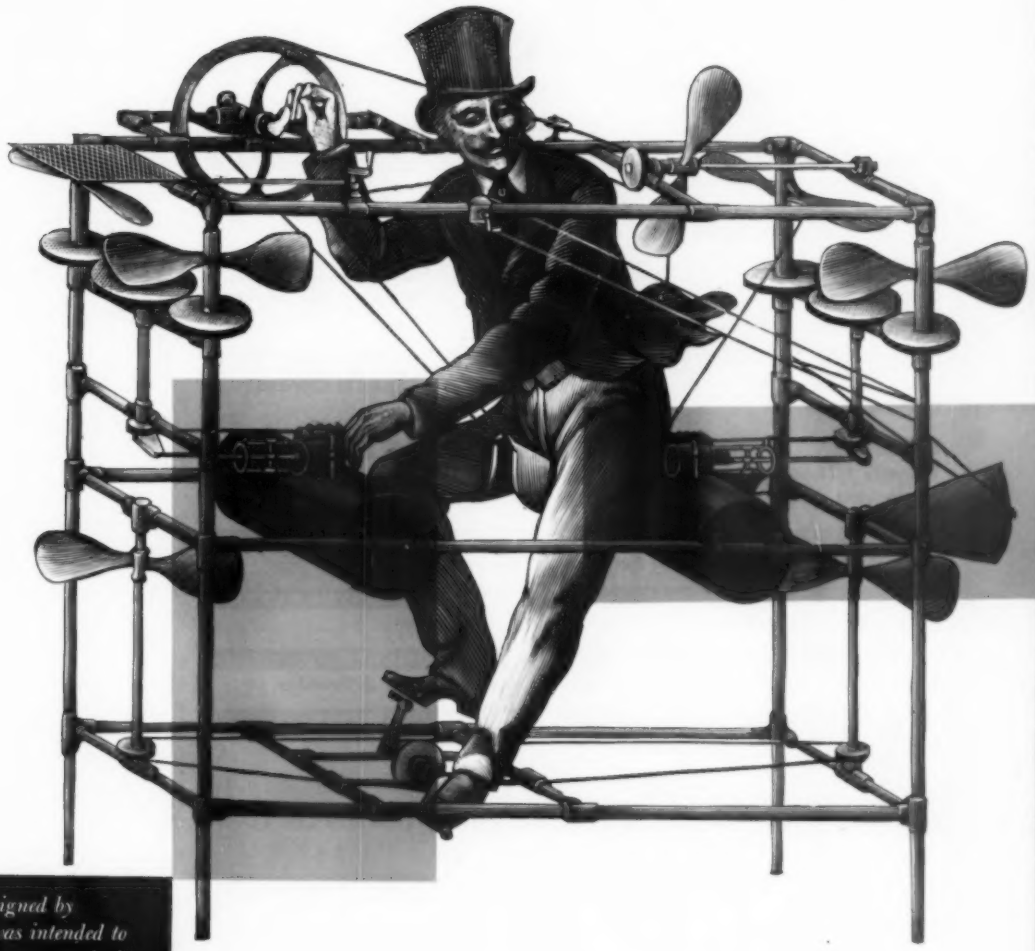
On June 12th, S. C. Miller, Navy Bureau of Ordnance, Washington, D. C., spoke on "Clarifying the Gray Areas of True Position Dimensioning."

"A Successful Approach to Electronic Accounting Machines or Electronic Data Processing," was explained by T. J. Moffett, Convair, General Dynamics Corporation, San Diego, Calif.

Open discussion by the participants centered on the retention and protection of original drawings as well as on the size of microfilm that should be recommended to the military as a standard.

Los Angeles Post Members Visit Pacific Missile Range At Point Mugu, Calif.

Los Angeles Post members enjoyed a "Day with the Navy" at Point Mugu, Pacific Missile Range Headquarters, on Monday, June 22nd. All hands traveled in chartered buses to the base where they were checked in and assembled in the cen-



Ayres' Aerial Machine, designed by Dr. W. O. Ayres in 1885, was intended to get off the ground through compressed air generated by foot power. In this illustration of the machine, Brussel-Smith, noted graphic artist, has used his unique wood engraving technique to depict for this advertisement another of man's efforts to find the power necessary for sustained flight.

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Association Affairs (Contd.)

ter theater for a welcome by Rear Adm. J. P. Monroe, Commander, Pacific Missile Range. The admiral was introduced to the crowd by C. C. Gabrielson, Post president.

Comdr. R. F. Freitag explained the geography of the missile range, which extends over 5,000 miles into the Pacific Ocean, and briefed the audience on the operations planned and in progress. Prior to luncheon a film entitled "Man in Space" was shown. At the luncheon Mr. Gabrielson presented a check from the Post to Admiral Monroe for delivery to the Navy Relief Society.

The highlight of the afternoon events was the launching of a Regulus I missile followed a half hour later by its recovery.

Among the weapons displayed were Talos, Bomarc, Regulus, Terrier, Thor, Nike-Hercules, Genie, Polaris, Bullpup, Asroc, Hawk, and Sidewinder. Target drones KDB-1, OQ-19, and SD-2 also were on deck.

About 4:30 p.m. the "meeting" moved out to a social hour and barbecue at Ventura Seaside Park arranged by the Ventura Chamber of Commerce, with many of the naval personnel who had taken part in the demonstration and tests as guests. They all were acclaimed for the excellence of the program.

Maj. James L. Wallace Receives H. W. Alden Award At Aberdeen Proving Ground

The Herbert W. Alden Award was recently presented to Maj. James L. Wallace in recognition of his outstanding achievement in the Ordnance Officer Advanced Class at Aberdeen Proving Ground, Md. Major Wallace is well known in A.O.A. Technical Division work as a former assistant secretary of the Standards and Metrology Division.

The award was presented by Col. Leo A. Codd, executive vice-president of the A.O.A., at the graduation exercises for the class. Ordnance School Commandant, Col. A. Mark Smith, II, presided and introduced Brig. Gen. H. F. Bigelow, chief, Office of Manpower, in the Office of the Chief of Ordnance. General Bigelow discussed the important task that faced the graduates and presented diplomas to the eighty American and twenty Allied officers.

The Alden Award, a check for $100, was founded by the Timken-Detroit Axle Company to honor Col. Herbert W. Alden, Ordnance Reserve Corps. Colonel Alden was chief engineer of Timken and for years maintained a close interest in ordnance engineering problems and performed many outstanding services for Army Ordnance. (*Continued on p. 266*)

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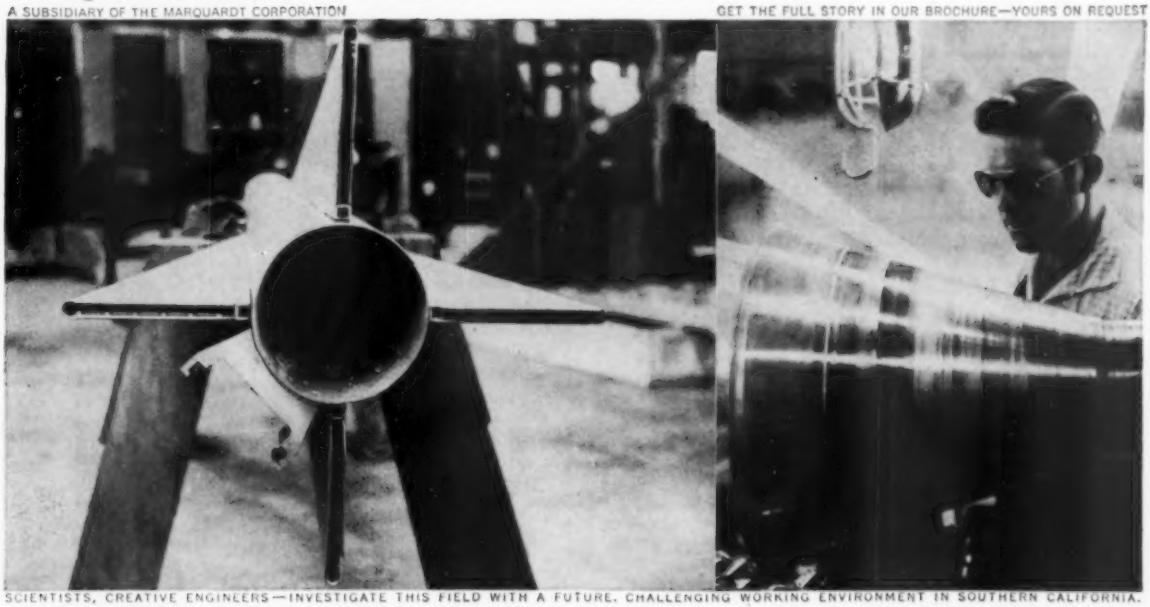

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Aberdeen Post Members See Army Weapons Demonstrated

On July 9th the members and guests of the Aberdeen Post received a taste of what is in store for the national membership at the Forty-first Annual Meeting on October 8th at the Aberdeen Proving Ground, Md. The occasion was the summer meeting of the Post which was attended by 210 members and guests.

The program included a dress rehearsal of the annual presentation of Army weapons to the cadets of the summer R.O.T.C. course. Included were the new M14 rifle and M60 machine gun; a drive-by of SS-10 and Honest John rockets, Corporal and Nike Hercules missiles; 105-mm. and 8-inch self-propelled artillery; M41, M48, M103 tanks; and a miscellany of combat vehicles.

Following dinner at the Main Officers' Mess, Col. J. P. Hamill, president of the Post, welcomed all and spoke briefly of the immediate plans of the Post.

Colonel Hamill, director of the Ballistic Research Laboratories, heads a new slate of recently elected Post officials. These are: Charles D. Nitchie of Koppers Company, first vice-president, and Halkey K. Ross of the Coating & Chemical Laboratory, second vice-president.

The directors of the Post for the year are: Rear Adm. Willis E. Cleaves, Bendix Aviation Company, outgoing president; Walter D. Smith, Martin Company; Morris D. Kaplan, APG; Dr. E. E. Minor, APG; Walter H. Ramsey, APG; and Richard W. Sanford, Aircraft Armaments, Inc. William E. Vaughn, Ordnance Training Command, is secretary-treasurer, and Francis X. Kelly of APG is the information officer.

A.O.A. Mine Section Studies Power Supplies For The Navy

At the request of the Navy Bureau of Ordnance and with the assistance of the Naval Mine Engineering Facility, Yorktown, Va., and the Naval Ordnance Laboratory, White Oak, Md., a special subcommittee of the Mine Section, A.O.A. Underwater Ordnance Division, has conducted a study of power supplies for naval mines. The following conclusions were reached:

1. The present state of the art dictates the use of LeClanche-type dry batteries for most design purposes. Versatility, availability, and cost are the major factors involved.

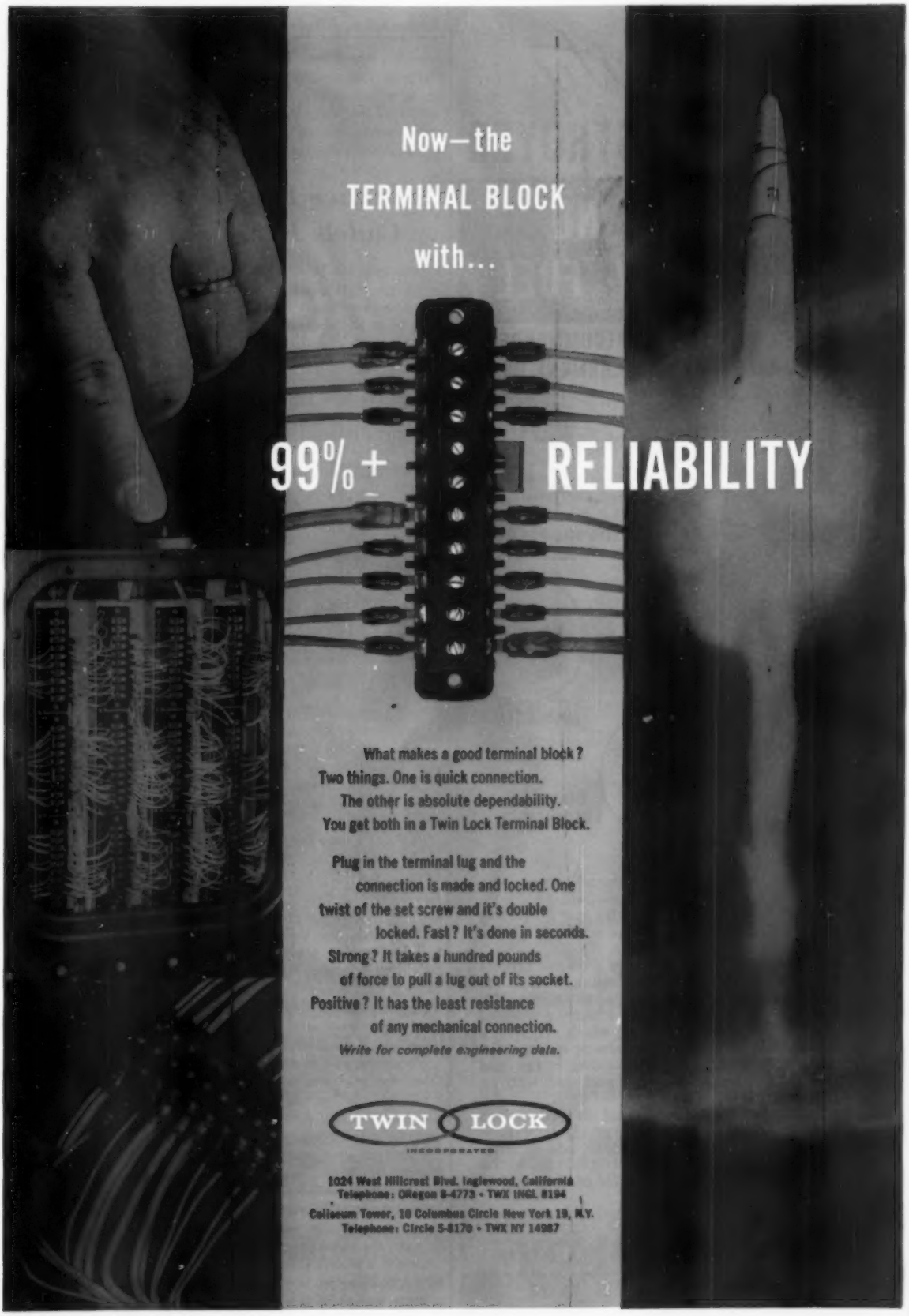
2. The current performance specifications for LeClanche-type batteries are generally satisfactory, and the introduction of tighter tolerances or greater demands for shelf life would not be economically feasible.

3. Refrigeration techniques, when properly controlled, are effective for the extension of the shelf life of LeClanche batteries.

4. The useful service life of a LeClanche battery cannot be predicted reliably from test data alone. However, if in the manufacture, handling, storing, and testing the batteries are kept in identifiable, homogeneous groups, some fairly accurate predictions of shelf life may be made by lot-sampling techniques.

5. The designers of new mines and mine components should make a concerted effort to standardize on a very small number of battery sizes and types. Further, efforts to standardize batteries in mines of earlier design are futile because of the space limitations and because of the extensive changes in configurations which would be required.

Finally, it was recommended that actions taken by the Naval Ordnance Laboratory and the Naval Mine Engineering Facility to evaluate the effectiveness of refrigeration techniques and to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establish procedures, identification, etc., are appropriate and that these organizations, together with the Bureau of Ordnance, are to be commended for their contributions to the state of the art. It appears likely that the use of these techniques will yield annual savings to the Government, in the mine program alone, of approximately one million dollars.

Ordnance R.O.T.C. Honor Cadets Receive A.O.A. Keys

Each year the honor Ordnance cadets in the R.O.T.C. units in colleges throughout the country are awarded the American Ordnance Association Scholarship Key. The awards were made recently to the students named below at the following institutions:

University of Arizona.—Cadet Capt. James C. Magee, Tucson, Ariz., is majoring in mechanical engineering and is vice-president of Tau Beta Pi, the scholastic honorary professional engineering fraternity; vice-president of Phi Delta social fraternity; a member of Sophos, sophomore men's honorary society; Scabbard and Blade, honorary military society; and the Traditions Committee.

J. C. Magee H. L. Hathaway G. T. Ogden

University of Arkansas.—Cadet J. L. Estes, Fayetteville, Ark., is majoring in chemical engineering and is a distinguished military student.

Bucknell University.—Cadet Gregory T. Ogden, Cape May, N. J., a distinguished military student, majored in mathematics. Campus activities included: Lambda Chi Alpha, Kappa Phi Kappa, Glee Club.

University of California.—Cadet Harry L. Hathaway, San Marino, Calif., was a distinguished military student. He received a B.S. degree in production management and finance. College activities included: Psi Upsilon social fraternity; president, Skull & Keys Society; secretary, Sophomore Men's Club; Interfraternity Council; member, Military Cadet Officers' Organization. Upon graduation he received a commission as a 2nd lieutenant, U. S. Army.

University of Cincinnati.—Cadet Shelley Meyer, Cincinnati, Ohio, was graduated with an engineering degree in June.

Clemson Agricultural College.—Cadet Capt. Frank D. Sams, Clemson, S. C., a distinguished military student, is vice-president of Phi Eta Sigma and Tau Beta Pi.

University of Connecticut.—Cadet Col. Roger W. Peterson, Manchester, Conn., majored in industrial administration. He was a distinguished military student, active in the Society for Advancement of Management and the Scabbard and Blade Society. He was also commanding officer of the Army Cadet Brigade, the highest position held by any cadet.

Cornell University.—Cadet David L. Brown, was graduated with a B.S. degree in civil engineering and was a distinguished military student. Active in campus affairs, he also was a mem-

(*Continued on page 272*)

Radioplane drones shown left to right: XQ-4B; RP-76; RP-77D; OQ-19; SD-1

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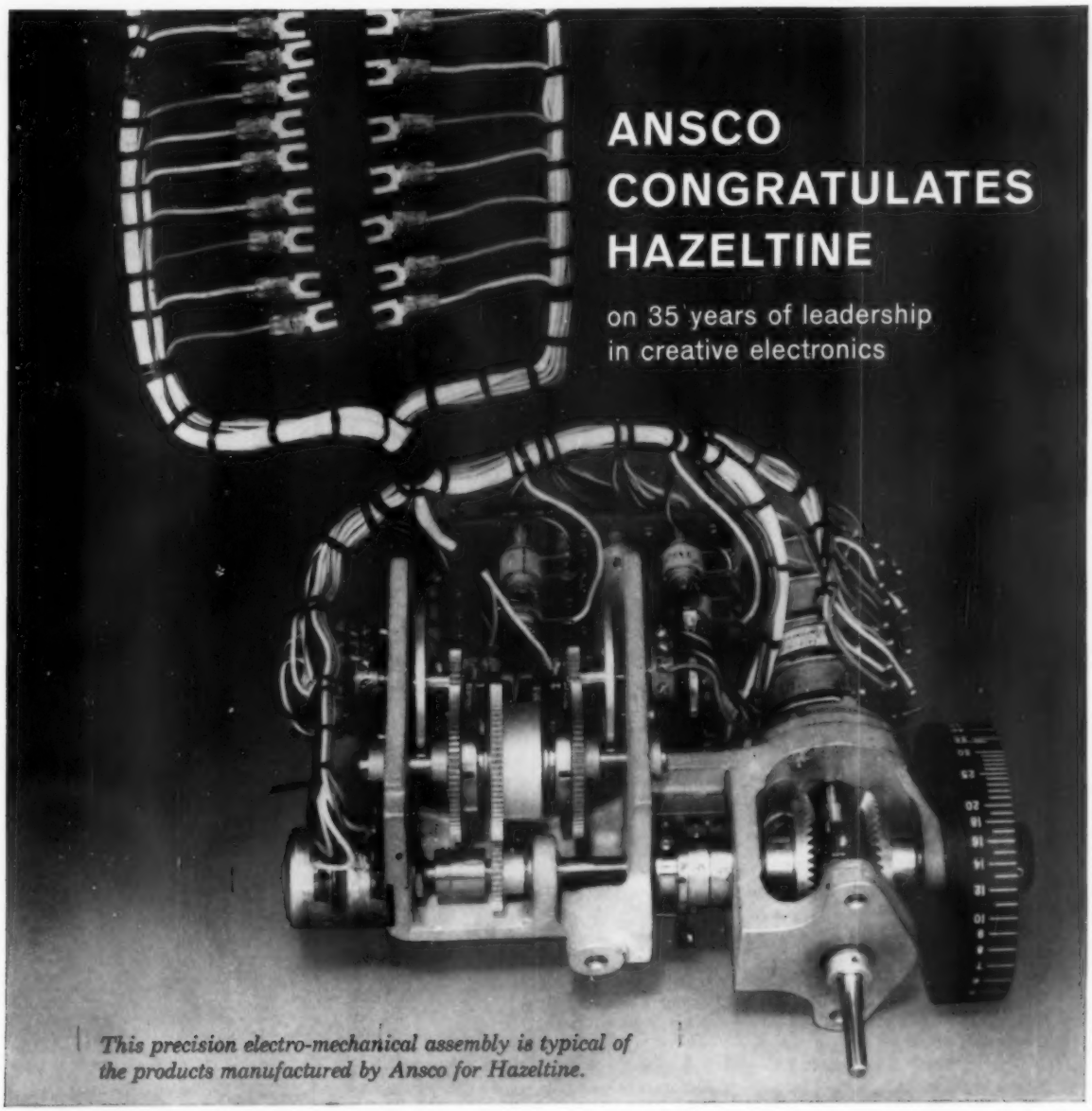

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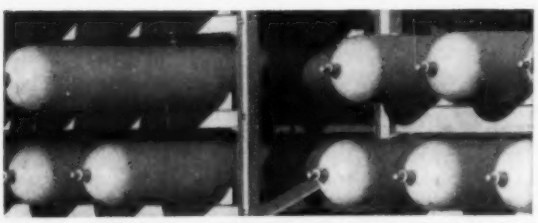

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Association Affairs (Contd.)

ber of Alpha Delta Phi fraternity; Rod and Bob society; president, Chi Epsilon fraternity; and an instructor in the Foundations Design Laboratory.

Dartmouth College.—Cadet Barclay Wellman, Jamestown, N. Y., participated in many college activities while maintaining a high scholastic record. He was advertising and space manager, Dartmouth College yearbook, and a member of Delta Kappa Epsilon fraternity.

Georgia Institute of Technology.—Cadet Richard P. Braden was an active member of the American Society of Mechanical

D. L. Brown F. D. Sams Barclay Wellman

Engineers and worked on the school magazine, *The Rambler.* He will begin active duty in January 1960 as a 2nd lieutenant, U. S. Army.

University of Illinois.—Cadet Dan J. Dannenfelt of Loves Park, Ill., is majoring in engineering physics and is a member of the Regimental Band, Marching Illini, varsity and R.O.T.C. rifle teams, and the Physics Society. He was elected to Phi Eta Sigma, Sigma Tau, Phi Kappa Phi, and Tau Beta Pi fraternities.

Lehigh University.—Cadet John J. Elengo, Jr., Hamden, Conn., received his B.S. in mechanical engineering. He was a member of the Scabbard and Blade Society. He was commissioned a 2nd lieutenant in the Ordnance Corps and was assigned to the Ordnance Officer Basic Course, Aberdeen Proving Ground, Md.

Massachusetts Institute of Technology.—Cadet Col. Walter J. Humann of Dallas, Tex., majored in physics and was a dis-

W. J. Humann D. J. Dannenfelt R. P. Braden

tinguished military student. He was a member of Sigma Xi, honorary societies, and president of the senior class.

Michigan State University.—Cadet Capt. James R. Gersonde, Colma, Mich., majored in marketing. Active in campus affairs, he was a member of the Varsity Tennis Team, Cadet Officers' Club, Interfraternity Council, Society for Advancement of Management, and Sigma Nu fraternity. Upon graduation he will be commissioned as a 2nd lieutenant, U.S.A.R., in the Ordnance Corps.

University of Minnesota.—Cadet Larry C. Oyen, Hayfield,

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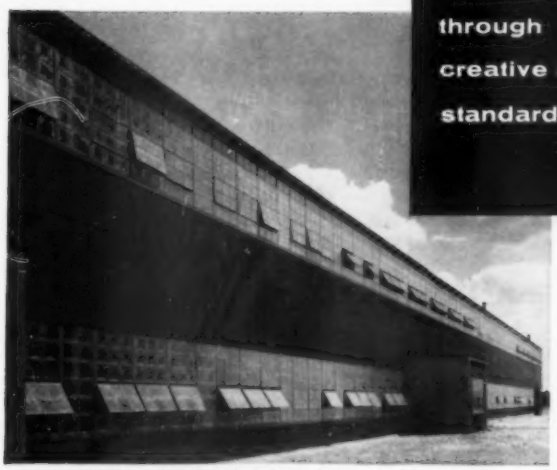
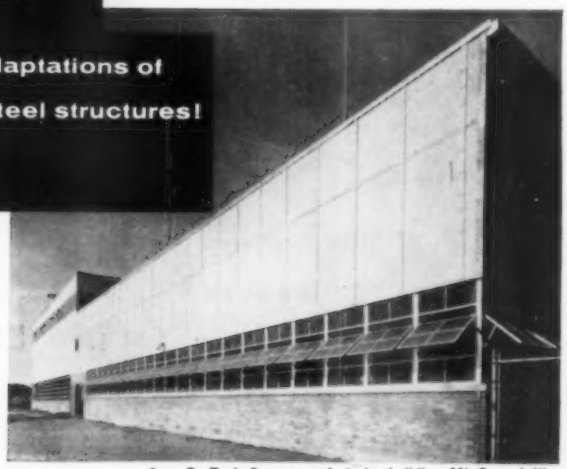


Youngstown Steel Door Co., plant, Youngstown, Ohio



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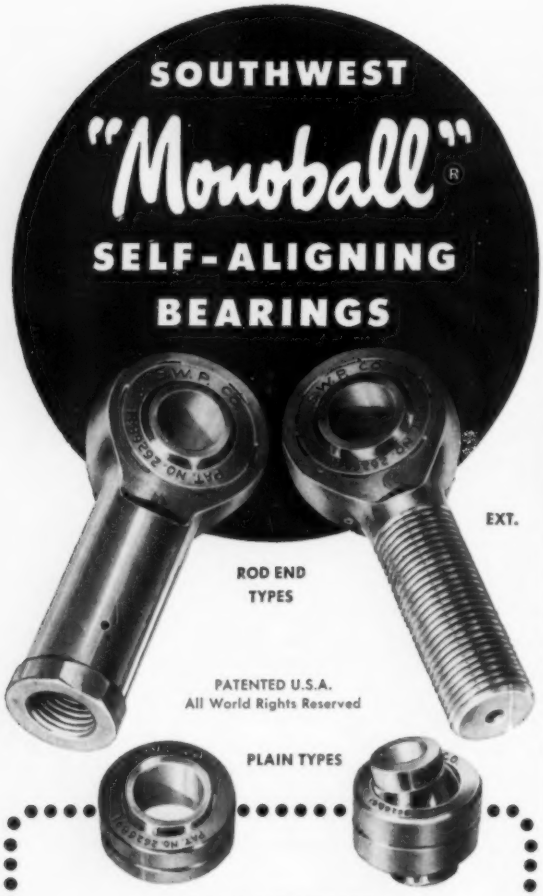

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Association Affairs (Contd.)

Minn., majored in mechanical engineering and was a distinguished military student. Cadet Oyen was commissioned in the Army Ordnance Corps.

North Carolina State College.—Cadet Lieut. Col. Lawrence Harris, Jr., Wake Forest, N. C., majored in nuclear engineering. He was a member of Phi Kappa Phi, Sigma Alpha Epsilon,

J. R. Gersonde Lawrence Harris, Jr. J. J. Elengo, Jr.

and Phi Eta Sigma. A distinguished military student, he was commissioned in the Ordnance Corps, U.S.A.R.

Pennsylvania State University.—Cadet Maj. John W. Andrews of Camillus, N. Y., majored in metallurgy. He was a member of Phi Eta Sigma, Phi Lambda Upsilon, Sigma Tau, and was commissioned in the Ordnance Corps, U.S.A.R.

University of Seattle.—Cadet Robert M. Coombs received the annual scholarship key award and was a distinguished military student.

University of Tennessee.—Cadet Col. Emmet P. Vaughn, Jr., Knoxville, Tenn., majored in business administration. He was a distinguished military student and his college activities included: Battle Group Commander; president, Scabbard and Blade Society; Phi Gamma Delta fraternity. He went on duty with the 82nd Airborne Division, Fort Bragg, N. C., in June 1959 as a 2nd lieutenant, Ordnance Corps, United States Army.

University of Toledo.—Cadet Col. Robert E. Butler is majoring in engineering. His school activities include: Phi Kappa Phi; Scabbard and Blade Society; Tau Beta Pi; member of university marching and concert bands; member of student board

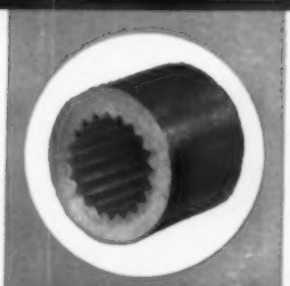
E. P. Vaughn, Jr. J. W. Andrews R. E. Butler

of governors; Interfraternity Council; Newman Club. He will apply for a Regular Army commission with Ordnance upon graduation in June 1960.

Virginia Polytechnic Institute.—Cadet Lieut. James W. Rakestraw, Portsmouth, Va., is a distinguished military student and majored in physics. Upon graduation he will be commissioned a 2nd lieutenant in the Ordnance Corps. He also received the Chicago Tribune R.O.T.C. award for military achievement, scholastic attainment, and character. (*Continued on p. 277*)

Another Meta-Dynamics Division development in

"Chipless machining"!



Ratchet
Material—AISI C-1020
Operation—Form I.D.
Production—300/hr.

Heat exchanger tubing
Material—Copper
Operation — Form fins
Production — 16″ of tubing formed per minute.

NEW CINCINNATI

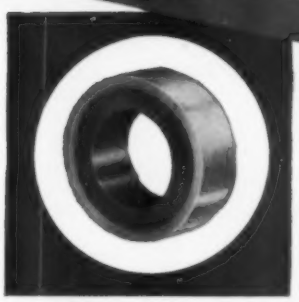
Intraform

Rapidly produces complex internal profiles to close tolerances, with low cost tooling.

This new *chipless machining* method makes possible low cost production of parts having intricate I.D. profiles that would be difficult or time consuming to machine by conventional methods.

Hollow cylindrical stock, ferrous or non-ferrous, with open or blind holes, is placed over a mandrel and "kneaded" by rapidly pulsating, rotating dies. The smooth, continuous kneading action redistributes the metal to reproduce the profile of the mandrel in the I.D. of the part. The work is formed to close tolerances and with fine surface finish. Tensile strength and hardness of the metal are also improved.

Work diameters ranging from ⅛″ to 5″ can be cold formed on standard Cincinnati Intraform machines, which can also be used for bonding laminated tubing and for reducing and tapering solid or tubular stock. For a description of the process and its many advantages, write for Bulletin M-2060, or call in a Meta-Dynamics Division field engineer.



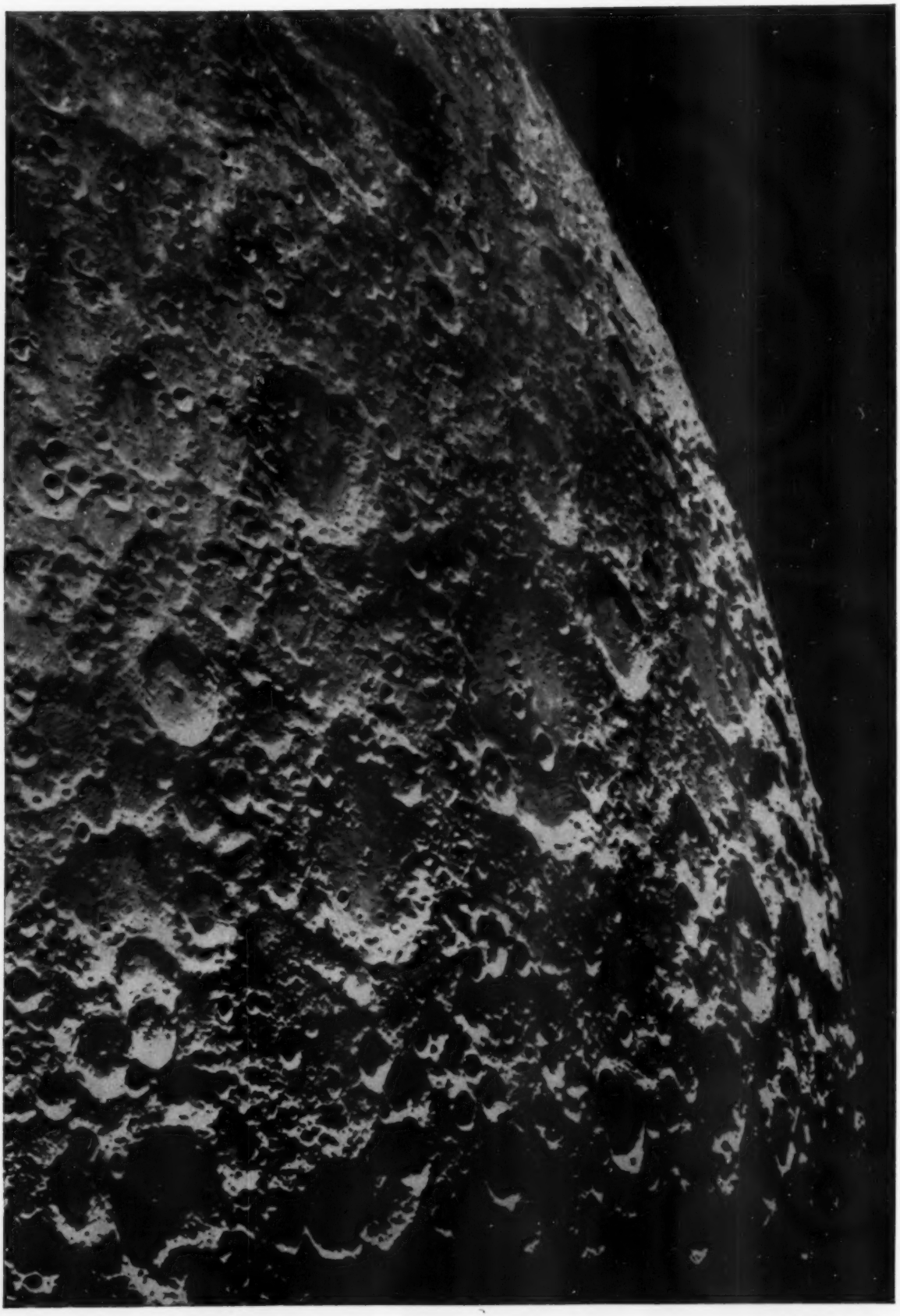
Laminated tubing
Material — Aluminum and copper
Operation—Bond copper lining to aluminum tube
Production — 24″ of tubing bonded per minute.

Left photo shows workpiece prior to Intraform operation. Note mandrel in front of part. Right photo shows workpiece after Intraform operation with profile of the mandrel reproduced in I.D. As workpiece feeds and mandrel does not, only a short, relatively inexpensive mandrel is required. Time for this operation was 16 seconds.

Intraform
META-DYNAMICS DIVISION
Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.

CINCINNATI



THE MILITARY REQUIREMENTS FOR MOON BASE

This is the title of one of four major space proposals developed by Martin for the military and astroscientific branches of our Government. The importance of this proposal is two-fold: the inevitability of an actual moon base program by this country within the next 5 years, and; the fact that we could and can undertake such a project now—not in theory but in "hard" engineering design. For Martin's eight divisions add up to one of the top capabilities in the free world for man's first ventures in space-planetary exploration.

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Necrology

• **LOUIS N. RIDENOUR, JR.,** vice-president of Lockheed Aircraft Corporation and a prominent research physicist, died in Washington, D. C., on May 22, 1959, at the age of 47. Dr. Ridenour addressed A.O.A. members at a technical seminar during the annual Industrial Preparedness Meeting in New York, N. Y., on December 3, 1958.

Born in Montclair, N. J., he received a bachelor of science degree from the University of Chicago in 1932 and a Ph.D. in nuclear physics from the California Institute of Technology in 1936. During World War II, Dr. Ridenour was assistant director of the Massachusetts Institute of Technology Radiation Laboratory. There he was instrumental in developing airborne radar and radar bombing systems. For his work in radar development he received the President's Medal for Merit.

After the war he taught at Princeton University and the University of Pennsylvania. He was subsequently made professor and dean of the University of Illinois' Graduate College.

Known internationally for his work in nuclear physics and electronics, he served as the first chief scientist of the Air Force. While with the Air Force in 1950-1951, he headed a special committee that surveyed the Air Force's research and development organization. The resulting "Ridenour Report" led to the establishment of the Air Research and Development Command.

Dr. Ridenour joined Lockheed's Missiles and Space Division in 1955 as director of research. He later became the division's assistant general manager and chief scientist. In March he was elected a vice-president of the corporation and was made general manager of the company's newly formed Electronics and Avionics Division.

• **WILLIAM M. ESCAVAILLE,** for many years director of advertising for this journal, died in Washington on July 2, 1959. He founded the Atlas Publishing Company in 1922 and became well known among the advertising fraternity throughout the country. He retired from the publishing business in 1949.

Born in Baltimore, Mr. Escavaille was educated in Washington and made his home in that city. During his tenure as advertising director of the A.O.A., over a period of more than ten years, he brought the advertising stature of these pages to high recognition as a technical and scientific journal of quality circulation among executives, engineers, and scientists of industry and our armed services. The Association is indebted to him for his superb service and records his name with gratitude in its annals as one who helped to add strength to its structure.—L.A.C.

NEW DEVELOPMENTS

Redeye Antiaircraft Missile

The Army and the Marine Corps have developed a new surface-to-air shoulder-fired guided-missile system called Redeye designed to provide combat troops with the capability to destroy low-flying strafing or bombing aircraft.

The Army Rocket and Guided Missile Agency, U. S. Army Ordnance Missile Command, Huntsville, Ala., has awarded a contract, totaling approximately $6,000,000, to the Convair Division of General Dynamics Corporation for development of the system. (See photo on page 234.)

Redeye is a man-transportable, shoulder-fired missile designed to destroy low-flying jets or conventional airplanes. The weapon is approximately 4 feet long, about 3 inches in diameter, and weighs approximately 20 pounds. The missile itself is a composite structure containing propellant, high-explosive warhead, and an electronic guidance system. Both the missile and its launcher can be carried easily by one man through underbrush and rugged terrain where no other type of antiaircraft weapon could be transported.

New Torpedo

A new submarine weapons system—Astor—capable of destroying submarines as well as surface vessels from greater distances than any presently operational underwater weapon, is now under development by the Navy.

Astor is an electric high-speed torpedo measuring almost twenty feet and weighing over one ton. It will be launched from submarines, but exact range of the new weapon has not been disclosed.

Westinghouse Electric Corporation, Baltimore, Md., is developing this new weapons system, under contract to the Navy's Bureau of Ordnance. The project is under the technical direction of the Applied Physics Laboratory of the University of Washington in Seattle.

Missile Warning System

The Ballistic Missile Early Warning System (BMEWS) being developed by the United States Air Force is an electronic system to provide detection and early warning of attack from enemy intercontinental ballistic missiles. The present objective is to provide a minimum warning of fifteen minutes.

Such a system has been made possible by recent scientific developments in electronics. For example, huge radars approximating the size of a football field have been developed which can detect a missile as far out as 3,000 miles. The power required for a single station would meet the electrical needs of a small city.

Three BMEWS stations are presently involved, although the location of only two, Thule, Greenland, and Clear, Alaska, have been announced. Thule will be the first to become operational, and work on both stations is progressing on or slightly ahead of schedule.

Corvus Missile

A test version of a new Navy liquid-propellant rocket-powered missile, the supersonic, air-to-surface Corvus, has been

Navy's Corvus air-to-surface weapon.

flown successfully at the Pacific Missile Range Test Center, Point Mugu, Calif.

The Corvus will be used by carrier-based aircraft and is designed to attack heavily defended areas, including surface ships. The new missile was developed by Temco Aircraft Corporation, Dallas, Tex.

New Detection Device

Swami, a small electronic security device to detect and measure movements up to thousands of feet away, recently was demonstrated by the Military Products Division of Singer Manufacturing Company. Swami (standing wave area movement indicator) is basically omnidirectional for detecting even the slowest movements throughout the surrounding area—even those behind shelves, counters, or other blind spots.

Extremely sensitive, it may be adjusted to overlook normal daytime activity or small movements such as caused by rodents. Once set to report the status of a closed room, it will report any abnormal changes in that room, such as an open file or vault door, even though at the moment there is no actual movement in the room.

This ingenious device is a sealed vacuum-tube envelope containing an ultra-high-frequency radio oscillator pulsed at a low-frequency repetition rate. Any motion within the area under surveillance induces a change in the low-frequency repetition rate which is detected by an FM detector. The detector transmits this intelligence to the monitor in the central control station in the form of a voltage fluctuation of high amplitude, which sounds the alarm.

Highly proof against countermeasures, it is currently being used by the Army for security purposes and is undergoing further tests for field use.

Silent Sentry Improved

An Army radar set, known as the Silent Sentry, AN/PPS-4, which can detect enemy movement at short ranges under the cover of darkness, smoke, or fog, has been greatly improved through the use of transistors.

Power requirements for the improved version are halved by switching from tubes to transistors. The new set will use a battery instead of a gasoline generator, enhancing its silent characteristics and resulting in improved maintenance and logistics.

The highly mobile Silent Sentry translates movements of tanks, trucks, or troops into identifiable sounds produced in the headset worn by the soldier operator. Using these "electronic ears," the operator is able to pick out and pinpoint the movement of targets within an area up to three miles.

Beryllium Break-Through

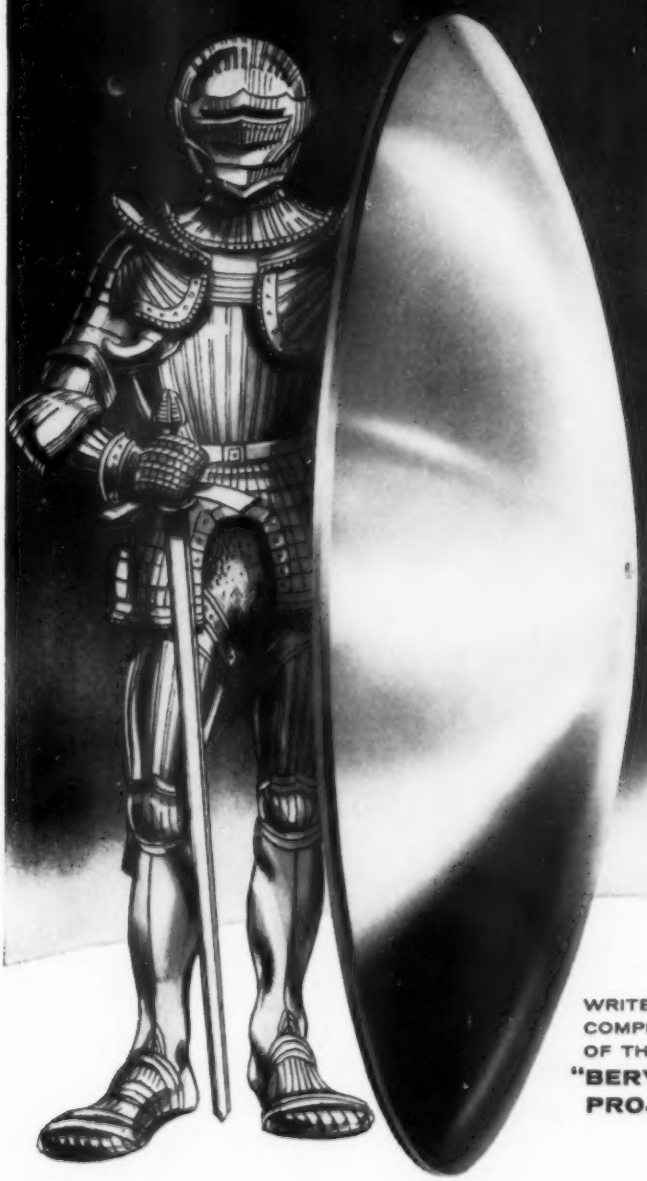
Martin Company engineers have successfully fabricated structurally sound beryllium sheet material which has been used to construct the world's first beryllium structure. Development and fabrication were performed in conjunction with Nuclear Metals, Inc., Concord, Mass.

Use of beryllium in basic airframes will make it possible to solve many of the aerodynamic and structural heating problems associated with space flight and reentry of the earth's atmosphere at speeds up to 18,000 miles an hour.

Ballistic missiles also can utilize beryllium in nose-cone construction to take advantage of the material's great heat-storage capacity because it can absorb 2½ times more heat than any other structural material under conditions of a given rise in temperature.

The properties of pure beryllium include a stiffness greater than steel, a strength

SHIELD FOR THE BATTLE OF SURVIVAL IN SPACE



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equal to the best aluminum alloys, and a weight equal to the lightest known structural material, magnesium. Until now, however, all characteristic forms of beryllium—castings, forgings, rolled sheet, etc. —have exhibited nonuniform properties and brittleness akin to glass. This obstacle now has been largely removed with the development of sheet material possessing homogeneous properties suitable for structural fabrication.

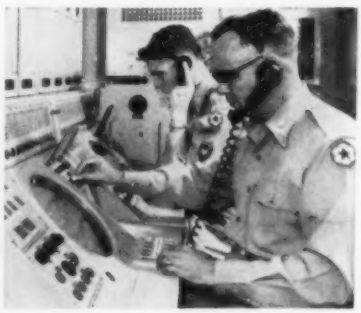
Aircraft Arrester

An airplane arrester called the "water squeezer" will be installed at Air Force bases throughout the United States to bring high-speed aircraft to a safe stop in a very short distance when an aircraft's braking system is inoperative. The "water squeezers" will replace the present anchor-chain arresters which were first used during the Korean conflict.

Air Force aircraft will employ an arrester hook which can be lowered by the pilot to engage a cable crossing the runway. The cable, in turn, is connected on both sides to an underground conical cylinder partially filled with water and antifreeze. As the airplane hooks the cable at speeds up to 160 knots, the cable pulls pistons through the liquid solution toward the small end of the conical cylinders. The farther a piston is pulled, the more resistance it encounters as it nears its own diameter in the conical chamber, bringing the aircraft to a smoothly decelerated stop. The system can automatically reset itself for another stop in a matter of minutes. It will be produced by the All American Engineering Company.

Army Air Defense

Overseas deployment of a new tactical air-defense system for battalion-level control and coordination of missile batteries in a field army was announced recently by the Army. Designated the AN/MSQ-18 by the Army Signal Corps, the system gives the air-defense commander in the field immediate control over antiaircraft missile batteries, even though they are dispersed over a wide area.



Operations central of air-defense system.

The system, housed in five 2½-ton trucks, consists of an operations central, from which an army battalion commander may observe the air battle, and four coder-decoder trucks. The trucks contain various electronic devices which in rapid sequence obtain data on the location of attacking aircraft and relay it to air-defense batteries ready to launch Army missiles such as Nike Hercules, Nike Ajax, or Hawk.

Use of the system eliminates time-consuming telephonic reporting and manual plotting of enemy aircraft. The process of pinpointing targets and firing antiaircraft missiles is reduced from minutes to split seconds.

New ¼-Ton Truck M151

The new M151 will replace the venerable Jeep as the Army's ¼-ton truck. Ford Motor Company will assemble the new vehicle at its Livonia, Mich., plant. The $15 million contract calls for 4,050 trucks, with completion by March 1960.

The new truck is 400 pounds lighter than the Jeep. It has a higher power-to-weight ratio, 30 per cent more cruising range on the same fuel load, and 26 per cent more cargo space. The body is made by Mitchell-Bentley Corporation, and the engine is a 4-cylinder Continental weighing 247 pounds. (*Contd. on p. 282*)

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radar breakthrough. A new radar system, developed by Bendix Radio, simultaneously searches and tracks . . . provides space-age detection capability . . . has superior operational reliability . . . and is safe from obsolescence. It is called ESAR—Electronically Steerable Array Radar. Employing techniques far superior to any used heretofore, ESAR generates tremendous power, and overcomes the performance limits of ponderous rotating antennas. This unique equipment, developed under the sponsorship of the Air Force Rome Air Development Center and the Advanced Research Projects Agency, also has applications other than radar detection. To learn how ESAR can solve advanced operational problems, consult us.

Bendix Radio Division
GOVERNMENT PRODUCTS • BALTIMORE 4, MARYLAND

Bendix
AVIATION CORPORATION

Improved Terrier Missile

Production of a weapon which will significantly increase the effectiveness of the U.S. Navy's missile defense against air attack is now under way. The weapon, an advanced version of the Terrier guided missile, has vastly improved performance compared with the original Terrier. It will supersede the present Terrier which has been operational with the U.S. Fleet since January 1958.

The U.S.S. DEWEY, a guided-missile frigate to be commissioned late this year, will be the first ship to get the improved weapon. The nuclear-powered aircraft carrier ENTERPRISE, as well as two conventional carriers, three guided-missile cruisers, and eighteen more guided-missile frigates, will get the missile. It eventually will be installed on the nuclear-powered guided-missile cruiser LONG BEACH and the nuclear-powered guided-missile frigate BAINBRIDGE.

The advanced missile will be able to intercept any present-day supersonic bomber many miles from its intended target. Like the original Terrier, the new weapon is a supersonic missile powered by two stages of solid-fuel rockets.

Rocket-Powered Target

A new target-missile altitude record was established recently at the White Sands Missile Range, N. Mex., during a U. S. Army operational and evaluation program. A rocket-powered target, produced

Army's RP-76 target missile.

by the Radioplane Division of Northrop Corporation in Van Nuys, Calif., blasted to an altitude of 61,800 feet at transsonic speeds. The 9-foot-long RP-76 target missile was launched on its record-breaking flight from an F-89 "mother" aircraft.

Reconnaissance Drone

First successful test flights of a new drone, controlled completely from the ground, for use by Army battlefield commanders in surveying enemy territory, have been completed.

Designed at Rheem Manufacturing Company's Aircraft Division at Downey, Calif., the drone carries electronic gear which reports back pertinent information to field commanders as the drone flies over enemy areas.

The drone is launched from a metal framework on a standard Army truck, assisted by two small rockets.

When it has completed its job it returns to the launching site for recovery. A parachute is released and the drone floats down to earth for reuse.

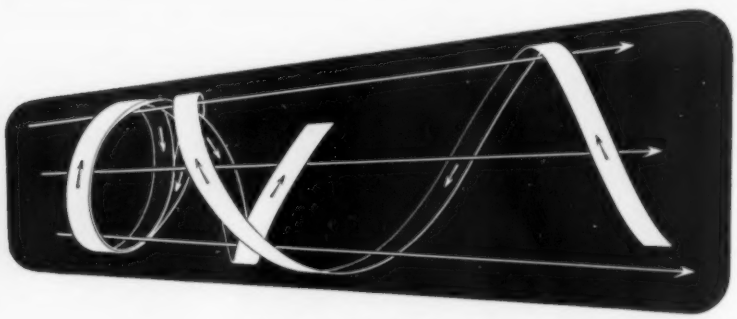
Project Tepee

A new radio monitoring system that can detect missiles and nuclear tests almost anywhere in the world has been developed by Dr. W. J. Thaler for the Navy. Known as Project Tepee, the system sends high-frequency radio signals around the earth, bouncing them between the ground and the ionosphere. The rocket exhaust from the firing of a missile or satellite or the radioactive clouds from a nuclear blast reflect these signals and reveal their presence, even around the curvature of the earth.

Ordinarily the Tepee system will not detect a rocket after its engine has ceased to fire since there is no charged gas to reflect the radio signal.

XV-3 Convertiplane

Bell Helicopter Corporation's XV-3 convertiplane can make a power-off reconversion from airplane to helicopter autorotation flight. Thus the XV-3's pilot, if the ship loses all power while cruising as an airplane, can reconvert its tilting prop-rotors upward to helicopter configuration and make a safe landing.



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G. C. DEWEY & CO., INC., 202 East 44 St., New York, N.Y.

Missile and rocket components, impact extruded from Alcoa Aluminum. The largest impact shown above has 8-in. diameter, 36-in. length; Alcoa can make them as large as 12-in. diameter, 60-in length. The impacts shown use aluminum alloys 1100, 6061-T6, 2024-T4 and 7075-T6.

WHAT'S NEW IN ALCOA IMPACTS?

IN A FIELD as revolutionary, promising and relatively new as impact extrusion, you'd expect progress to be made *rapidly*. And it has! In the years since Alcoa pioneered this breakthrough in the metal-working arts, the impact process has been advanced and extended to cover a wide variety of shapes and forms and special applications . . . to cut costs in dozens of ways . . . and to produce, in the wink of an eye, complex components with tolerances down to 0.005 in.

EACH OF THE IMPACTS shown above is in production. Each represents at least one complexity that formerly would have posed a real production headache: each achieves the optimum properties of its particular alloy.

TOOLING COSTS? With few exceptions, the cost of impact tooling is substantially less than for other fabricating processes. This is especially true where the length of the part would require several steps by any other process—but with the impact process, even extremely long parts can be produced with just one set of tools and one operation, simply by varying the size of the original blank or slug.

IN GENERAL, it's an excellent idea to consider virtually *any* closed-end or tubular design as an Alcoa® Impact. For more specific information, and for on-the-spot assistance, the *best* procedure is to contact your nearby Alcoa sales office. Or, if you prefer, write to: Aluminum Company of America, 2031-J Alcoa Building, Pittsburgh 19, Pa.

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MATERIALS PROGRESS

George S. Brady

Aluminum and Defense.—Less than three years ago the Bureau of Business Research of the University of Illinois published a comprehensive report on the rising demand for aluminum, a report which some considered as too optimistic in forecasting total United States consumption of the metal as reaching close to 4,500,000 tons per year by 1965, or about double the 1958 capacity. It was estimated that of this amount 400,000 tons would be for direct military use.

However, the report did not attempt to indicate what the annual demand for aluminum would be in an all-out war and apparently assumed merely the projection of our cold-war "defense" program. In 1950, the first year of the Korean war, the total American production was only 719,000 tons. Actually, military adoption of aluminum in present and projected equipment designs since the Korean war has been so spectacular that any figures based on past usage would have been valueless, anyway, for estimating requirements.

Reynolds Metals Company has recently made a survey of present and projected aluminum use in new military equipment that constitutes an interesting and useful base for study of the place of this metal in any new war. Reynolds engineers estimate that military uses of aluminum already total more than 200,000 tons a year even with only a relatively small cold-war production of new designs for trial and training purposes.

Aircraft was the big consumer of aluminum in the last war. Missiles now join aircraft as a potential big user. But the projected uses in ordnance, ammunition, ships, transport equipment, and transportable buildings, bridges, and other devices will exceed these many times. Mobility, an outstanding factor in modern mechanized warfare, has been given a tremendous impetus by the use of aluminum.

The new M113 personnel carrier contains four tons of aluminum, including aluminum armor plate. Its total weight was cut in half, permitting one engine to be substituted for two with consequent less maintenance and a doubled fuel mileage, an increase in speed from 32 to 40 miles an hour, and a range increase from 120 to 200 miles.

In the aluminum-redesign of the Army 2½-ton truck, the new test model XM-410 with eight independently sprung powered wheels has exceptional lightness and a watertight body that permits the truck to be floated across rivers while carrying a 5,000-pound load.

The new tanklike aluminum self-propelled 105-mm. howitzer weighs only 33,500 pounds compared with 53,000 pounds for the previous steel model. With a lower silhouette, it has more space for the crew and can fire while swimming a river. A new aluminum flame thrower weighs only twenty-six pounds compared with seventy-two pounds in the old model, and it can be jumped with a paratrooper.

New applications of aluminum to military and naval equipment are now so diverse that it is not possible here to give even a listing. Possibly enough has been said to indicate that in any future war the demand for aluminum will be tremendous compared with the old standards of the past. Light weight, besides added mobility, brings fuel economy—an item of great importance in field transport.

Aluminum also cuts the problem of rusting and paint maintenance. The metal is nonshattering, has high reflectivity of heat and light, low resonance, and does not retain radiological contamination for as long as most other metals. These are some of the factors that have guided military designers to increasing use of the metal.

Per capita consumption of aluminum has doubled since 1950, but this is no lead to what the demand would be in case of an all-out war. Basing a judgment on the present trends in military design, the "realistic" necessary United States production figure of 4,340,000 tons by 1975 as computed by McGraw-Hill economists, based on increasing civilian per capita needs, is altogether too low to meet the requirements of a full-scale war.

Geodesic Dome.—The 200-foot-diameter geodesic dome for the American exhibit in Moscow was produced from aluminum sheets furnished by *Kaiser Aluminum & Chemical Sales, Inc.* The dome weighs 104,000 pounds and has 14 different sizes of diamond-shaped panels. The gold-anodized aluminum panels were shipped flat to be formed abroad, but no brake-press suitable for forming was available in Russia and a press had to be sent from the Brooklyn Navy Yard.

Improved Alloy.—Complicated structural parts in the Air Force F-104 Starfighter jet plane (1,000 m.p.h.) are cast in aluminum alloy 356. This alloy, containing 7 per cent silicon and 0.3 magnesium, normally has large needlelike silicon crystals which tend to make the alloy brittle, but a small amount of sodium, not exceeding 0.04 per cent, added to the aircraft alloy, refines the crystals to a finely dispersed form and improves the physical properties of the alloy. For high-strength extrusions and forgings, as well as for sheet, the aluminum alloy 7075-TS was used.

Stainless Steel for Atomic Ship.—Stainless-steel castings have been used extensively in the power plant of the first atomic-powered merchant ship, the N.S. SAVANNAH. The reactor is fueled with uranium oxide to give 3½ years' service on a single core loading. Volutes and impellers, designed by *Babcock & Wilcox Company*, are Type CF-8 stainless, the volute and casing weighing 3,150 pounds.

There are 36 Type CF-8 castings in the reactor vessel, with 21 cast transition pieces, each weighing 180 pounds before machining. Valve bodies are also made of Type CF-8 steel. This steel has a nominal composition of 19 per cent chromium, 9 nickel, and 0.08 maximum carbon.

Parts are designed to withstand a pressure of 1,750 pounds per square inch at a temperature of 500 degrees Fahrenheit. Castings were selected instead of forgings or welded assemblies because of the complex shapes and because large fillets were needed to eliminate crevices which might entrap radioactive particles.

High-Temperature Lubricant.—A metapolyphenol ether lubricant with a decomposition point at about 862 degrees Fahrenheit, or well above that of the silicones, has been developed by the *Monsanto Chemical Company*. Tests have shown that it will give a useful life as a lubricant for 80 hours at 900 degrees Fahrenheit. The material is now available in development quantities and can be used as a jet-engine lubricant and as a high-temperature hydraulic fluid.

High-Performance Alloy.—*Haynes Stellite Company*, Kokomo, Ind., is now rolling its Haynes 25 alloy into sheets as thin

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

as 0.010-inch for missile and aircraft uses and for chemical equipment. This is a cobalt-base alloy containing chromium, nickel, and tungsten. Because of the high yield strength of the alloy, the cold rolling is done at very high pressure. The cold-rolled sheets, when given an aging heat treatment, have a yield strength of about 180,000 pounds per square inch, resist oxidation, and retain strength to 1,800 degrees Fahrenheit.

Miniature Ball Bearing.—In a new miniature ball bearing made by *Thomson Industries, Inc.*, Manhasset, N. Y., with the outside diameter of the bushing only 0.3125-inch, there are three ball circuits, each circuit having a minimum of 16 stainless-steel balls. The outer sleeve is also of stainless steel, and the ball retainer is brass. The shaft diameters are 0.1246- and 0.1871-inch.

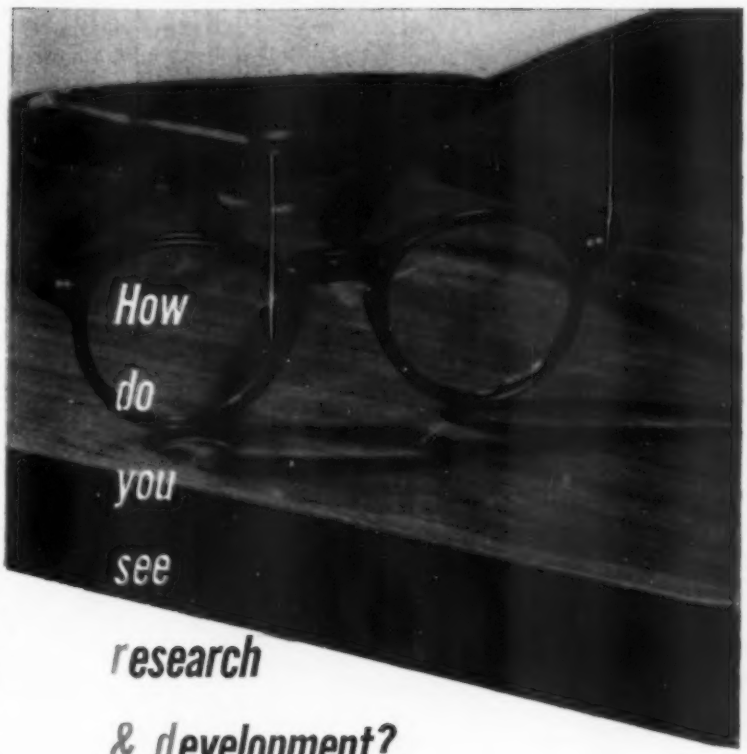
Nylon Hinge.—*American Plastics Corporation*, Bainbridge, N. Y., has a new line of nylon hinges with the two leaves molded together inseparably without a pin. The hinge needs no oiling, is strong and nonsticking, and is unaffected by weather conditions.

New Semiconductor.—A new semiconductor material that can be used for operating temperatures as high as 1,500 degrees Fahrenheit has been developed by the *Westinghouse Electric Company*. It is an indium-arsenide-phosphide produced by chemically combining indium with high-purity arsenic and phosphorus.

Fused Shapes.—Fused silica shapes are now being produced by the *Glassrock Corporation*, Atlanta, Ga., in large sizes that permit use for permanent molds for casting metals, and for furnace hearths, furnace fixtures, and crucibles. Parts as large as six feet square and eleven inches thick have been made and will withstand repeated heating and rapid cooling from 2,000 degrees Fahrenheit without cracking.

The slip-cast material has a porosity of 12 to 18 per cent, a tensile strength of 1,500 pounds per square inch, a compressive strength of 20,000 pounds per square inch, and a melting point of 3,100 degrees Fahrenheit. Porous castings, with a porosity of 50 to 60 per cent, also are made.

Plastic-Lined Pipe.—To replace alloy pipe for carrying corrosive liquids, *Jones & Laughlin Steel Corporation*, Pittsburgh, Pa., is now producing resistance-welded carbon-steel pipe lined with polyvinyl chloride plastic. It has a lower coefficient of friction and thus less resistance to flow than the alloys it replaces. The pipe, called Jal-Jacket, comes in sizes from 2 to 4 inches, in 20-foot lengths, for



Some people see that some smaller R&D firms can rally greatly diversified capabilities and, at less expense, better focus these capabilities on *the problem* that needs to be solved *now.*

Some people see an answer to only a portion of an engineering problem, without scanning the whole picture to see what the answer will be good for after it has been developed.

Lots of people see in WTA a smaller R&D firm that does have an extraordinary range of capabilities which have been successfully focused on unusually tough engineering problems—*with the whole picture in mind!*

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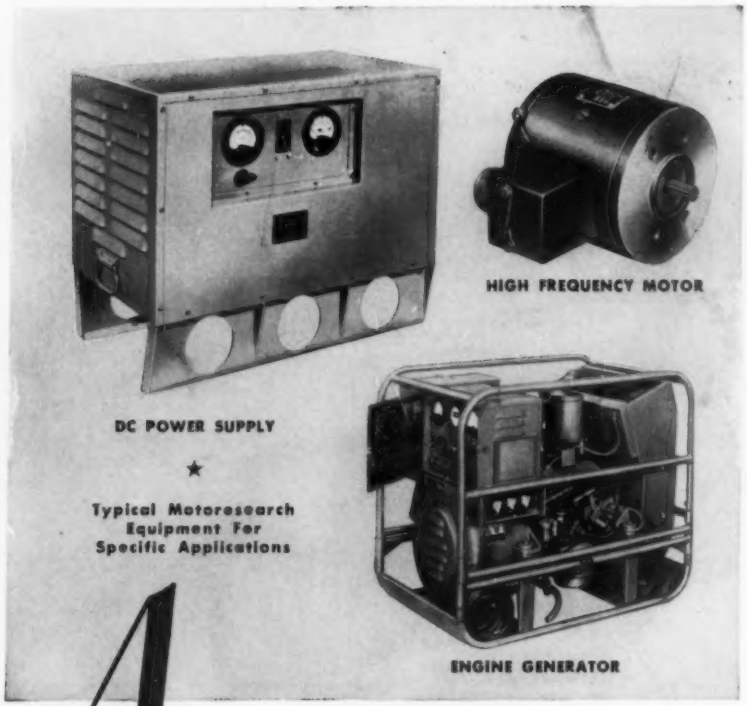

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Materials Progress (Contd.)

a pressure of 1,000 pounds per square inch. The temperature limit, however, is 150 degrees Fahrenheit.

Polyethylene Pipe.—*Yardley Plastics Company*, Columbus, Ohio, has a new line of plastic pipe that will withstand a working pressure of 60 pounds per square inch at a pumping water level of 150 feet. The plastic used in the pipe is a high molecular weight polyethylene, with the molecular chains averaging about 70,000 carbon atoms in length, produced by the *Allied Chemical Corporation*, New York, N. Y. The pipe comes in 1-, 1¼-, and 1½-inch sizes and is provided with nylon fittings.

Crystalline Plastics.—Since the successful introduction of one crystalline plastic, much investigative work has been done on the matter of a polycrystalline phase in other plastics to broaden the field of use. Conventional plastics are amorphous, or an irregular mixed structure of amorphous and crystalline. This gives only moderate tensile strength, a creep that does not permit heavy load bearing, a wide softening range, and brittleness at low temperatures.

With crystalline, or spacially oriented molecules, plastics could have higher physical properties for mechanical and structural parts. This has been done with fibers and films by stretching to give mechanical orientation, but the process is not applicable to shapes.

Battelle Memorial Institute has been doing some research on the crystallization of polymers by heat treatment to promote crystal growth, but this method, from labor and other standpoints, is not ideal. Battelle researchers believe that a pure uniform crystal structure eventually will be obtained by a proper selection of catalysts.

Teflon Piston Rings.—Tests made by *E. I. du Pont de Nemours & Company* engineers have indicated that Teflon (tetrafluoro ethylene) piston rings last as much as 20 times longer than cast-iron rings for compressor use in a temperature range from minus 320 to plus 500 degrees Fahrenheit. It was found that in a compressor where there was exposure to wet hydrogen at a pressure of 4,500 pounds per square inch, 6 Teflon rings could replace 26 cast-iron rings.

Elastic Cast Iron.—*General Motors Foundry Division* has developed a cast iron that has a strength and an elastic modulus nearly equal to cast steel, with castability much superior to that of steel. The iron, called Centra Steel, contains 1.70 per cent carbon, 2.25 silicon, 0.40 manganese, 0.01 boron, 0.10 sulphur, and 0.05 phosphorus. As cast, the material has

Edwin Felch, project director in charge of developing the Titan guidance system, holds the "voice" of the ICBM.

VOICE OF A GUIDED MISSILE

This is a missile-borne transmitter. It is the "voice" of a missile in flight . . . part of a new radio-inertial guidance system developed by Bell Telephone Laboratories for the Ballistic Missile Division of the Air Force.

This versatile system helped deliver the nose cone of a Thor-Able test missile precisely to its South Atlantic target area—5000 miles from Cape Canaveral, Florida. So accurately was the nose cone placed that a waiting group of ships and planes retrieved it in a matter of hours. It was the first nose cone ever to be recovered after so long a flight.

The command guidance system which made such accuracy possible combines precision tracking radar with a special Remington Rand Univac computer. Fed a steady stream of signals from the missile-borne transmitter, the ground-based equipment compares the missile's flight path with the preselected path. Corrective steering orders are computed and transmitted automatically to the missile. The ground station monitors the progress of the flight continuously and obtains immediate evaluation of mission success. And since the principal control equipment is kept on the ground, expendable hardware in the missile itself is minimized.

This radio-inertial guidance system is a product of the Bell Laboratories-Western Electric development-production team. It is in production at Western Electric for the first operational squadrons of the Titan intercontinental ballistic missile.

Bell Labs scientists and engineers developed the world's most versatile telephone network and much of our nation's radar. They have constantly pioneered in missile systems. From their storehouse of knowledge and experience comes this new achievement in missile guidance.

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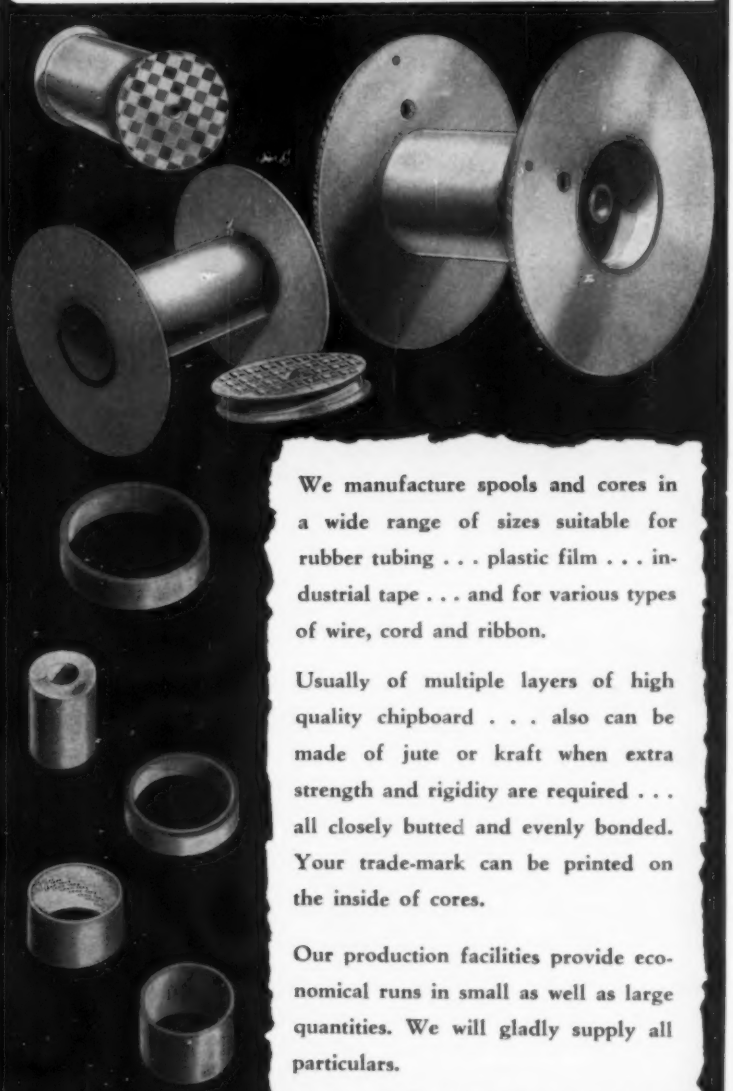

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Materials Progress (Contd.)

a compacted carbon similar to that of malleable iron.

Silver-Lithium Alloy.—*Handy & Harman* has found that the addition of small amounts of lithium to standard silver brazing alloys increases the fluidity and wetting properties and makes them suitable for strong brazing of stainless steels without the use of a flux. It also was found that silver-lithium alloy with 2 to 3 per cent lithium gives a good bond for titanium.

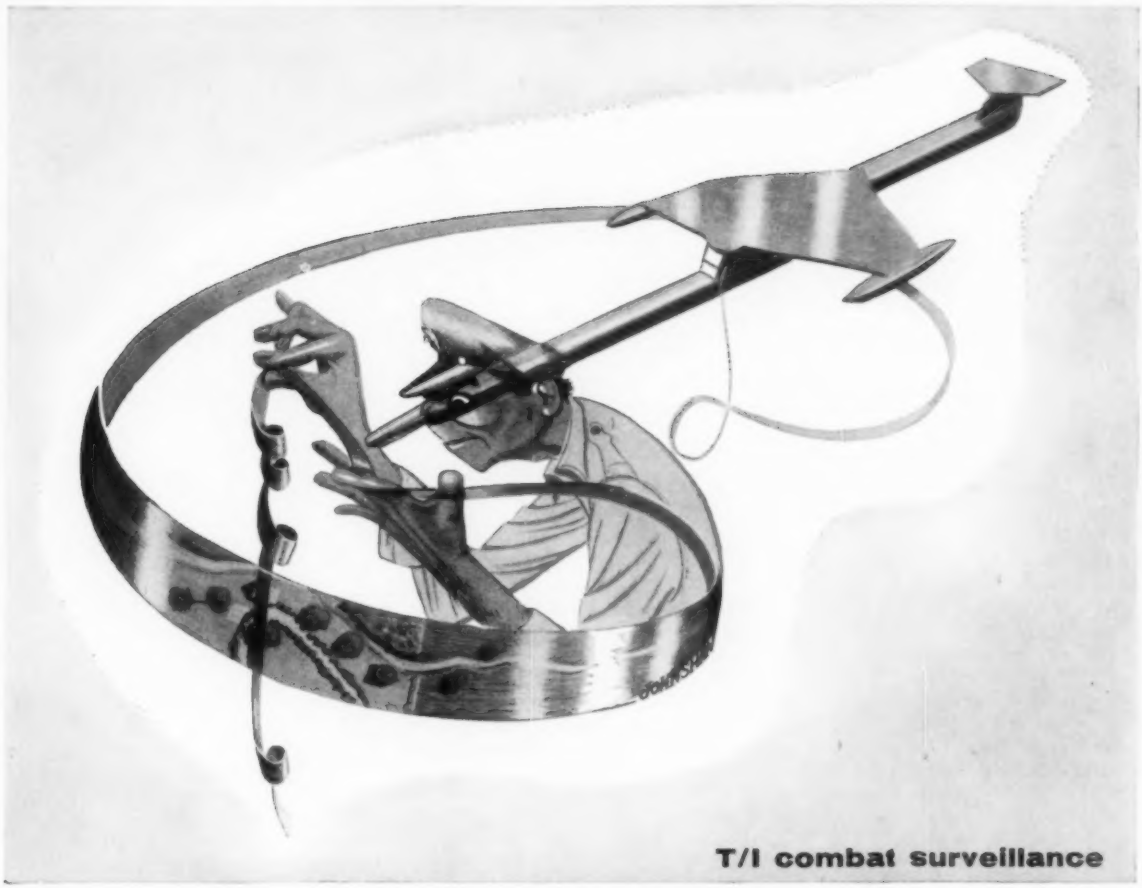
New Glasses.—An entirely new series of glasses with very low melting points that can be poured easily for encapsulating electronic devices, or vaporized and condensed as thin films, has been developed by *Bell Telephone Laboratories, Inc.*, New York, N. Y. The glasses so far made have melting points ranging from 260 to 660 degrees Fahrenheit. They are compounded with various amount of sulphur, selenium, thallium, and arsenic, and formulations can be made to suit specific requirements.

Some of the glasses are semiconductors and some are insulators. Those containing selenium give high adhesion to metals and to other ceramics. All of them are resistant to water, acids, solvents, and dilute alkalies. Unlike ordinary silica glasses, they will resist the action of hydrofluoric acid.

High-Temperature Insulation.—The problem of meeting the high-temperature requirements of electrical wiring in missiles and other military equipment has been solved by *United Electrodynamics, Inc.*, Pasadena, Calif., with a tightly braided silica fiber insulation. Copper wiring, or silver-clad steel conductors, can be used with the silica braid for temperatures to 500 degrees centigrade. The insulation is very flexible and has a low-loss characteristic.

Atomic Thermocouple.—*Los Alamos Scientific Laboratory* has developed a thermocouple for converting heat directly into electrical energy. The couple consists essentially of a cylinder of uranium carbide and an ionized cesium metal as the second element. The small laboratory model, when attached to receive the fission heat of a reactor core, generates 100 watts with a current of 30 to 40 amperes.

Vacuum Cadmium Coating.—Hydrogen embrittlement, which has been a serious disadvantage in the use af cadmium plating for the corrosion protection of high-strength steel parts such as bolts and landing-gear structures, has been eliminated by the *National Research Corporation*, Newton Highlands, Mass., by applying the cadmium coating by the vacuum process.



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ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—Project Mercury, the U.S. manned satellite program, has entered the pilot-training phase. Candidates will train in basic science, space-flight familiarization, Mercury capsule operation, participation in the actual development program, training in aircraft flights, and integration with launch crew and ground components. All will fly in aircraft during short weightlessness tests. Due next will be a 5-minute weight-free ride in an Army Redstone ballistic missile.

Meanwhile Little Joe rockets are being delivered to NASA at Wallops Island, Va., for tests on parachute deployment of capsules and to study effects of acceleration and water impact. Six rockets are on order. The first, already delivered, will be fired empty, one reserved as a spare, and the others will carry primates in flight tests. Little Joe—an all-solid rocket—is composed of four modified Sergeants and four Recruits. Total thrust of the combination is around 472,000 pounds; diameter is 6 feet, and length is 44½ feet.

At the present time it is not known whether the Jupiter missile will be used in the Mercury program. After an astronaut took the Redstone ride, it was planned that he would take a longer ride in the Jupiter missile. Then would come Big Joe and reentry tests with the Atlas ICBM as the booster rocket. Finally, a manned satellite attempt was planned after all components had been tested.

As NASA now sees it, though some schedules have been drawn up, man will ride in orbit only when it is sure that it can be done successfully and safely.

Project Saturn, too, is moving along. This ARPA project is being developed for large-scale space ventures. By 1962-1963 it will provide an efficient and reliable system for lifting multiton payloads into high orbit around the earth and into deep space. The Saturn space vehicle is described as being capable of landing 1,000 to 2,000 pounds of scientific instruments gently on the surface of the moon.

Saturn is a multistage rocket. First stage will be a cluster of 8 H-1 (Jupiter missile) rocket engines and will produce about 1.5 million pounds of thrust. The first stage will be about 75 feet tall and 22 feet in diameter. The second stage will be a modified Titan second stage somewhat longer than the regular 54 feet and will be 10 feet in diameter. Second-stage thrust will be 360,000 pounds. The first two stages will use liquid oxygen as an oxidizer and a hydrocarbon fuel.

The third stage will be the Centaur rocket with 2 engines delivering 30,000 pounds' combined thrust. Its diameter also will be 10 feet. This last stage will use liquid oxygen and liquid hydrogen fuel. The 3-stage Saturn will weigh about 580 tons at launch, 500 tons of which will be propellant. It will stand about 200 feet tall, nearly half as high as the Washington Monument. A fourth stage, as yet unselected, may be added later for specific missions.

The first-stage cluster will be static-tested on a special 175-foot tower now nearing completion at Redstone Arsenal, Ala. Flight tests will be made from the Atlantic Missile Range at Cape Canaveral, Fla., where a 305-foot self-propelled service stand will be built to handle the huge rocket. Funds committed to date for this program total $34 million. First flight test is scheduled for late 1960. The Saturn rocket will be able to orbit a communications satellite weighing several tons at an altitude some 22,000 miles above the earth. This will result in a 24-hour orbit—the so-called stationary orbit—since the satellite will remain fixed in relation to a fixed point along the equator. Such a satellite will become an essential part of a worldwide military communications system.

Aerodynamics.—Reduction of deceleration loads in reentering rocket vehicles can amount to about fifty per cent without affecting the aerodynamic heating of the vehicle. Continuous drag modulation, according to the Space Technology Laboratories, is accomplished by the use of retractable paddles or a movable spike. Such systems might be useful when a rocket returns from the moon, for example. By using aerodynamic lift, the range of allowable reentry angles is greatly increased. Only modest lift-to-drag ratios are needed. For return from the moon or other planets, the need for multiple-pass drag braking is eliminated.

Scientists at the University of Michigan find that side jets offer a sizable and useful interaction force (enough for control purposes) in supersonic vehicles at altitudes up to 100,000 feet. Such controls are used in rockets, but this study indicates that reaction controls could compete with conventional aerodynamic controls for use within the atmosphere.

Lift or thrust augmentation for supersonic vehicles at high altitudes is possible simply by burning fuel on aerodynamic surfaces. Harvard University and NASA have been working with this technique.

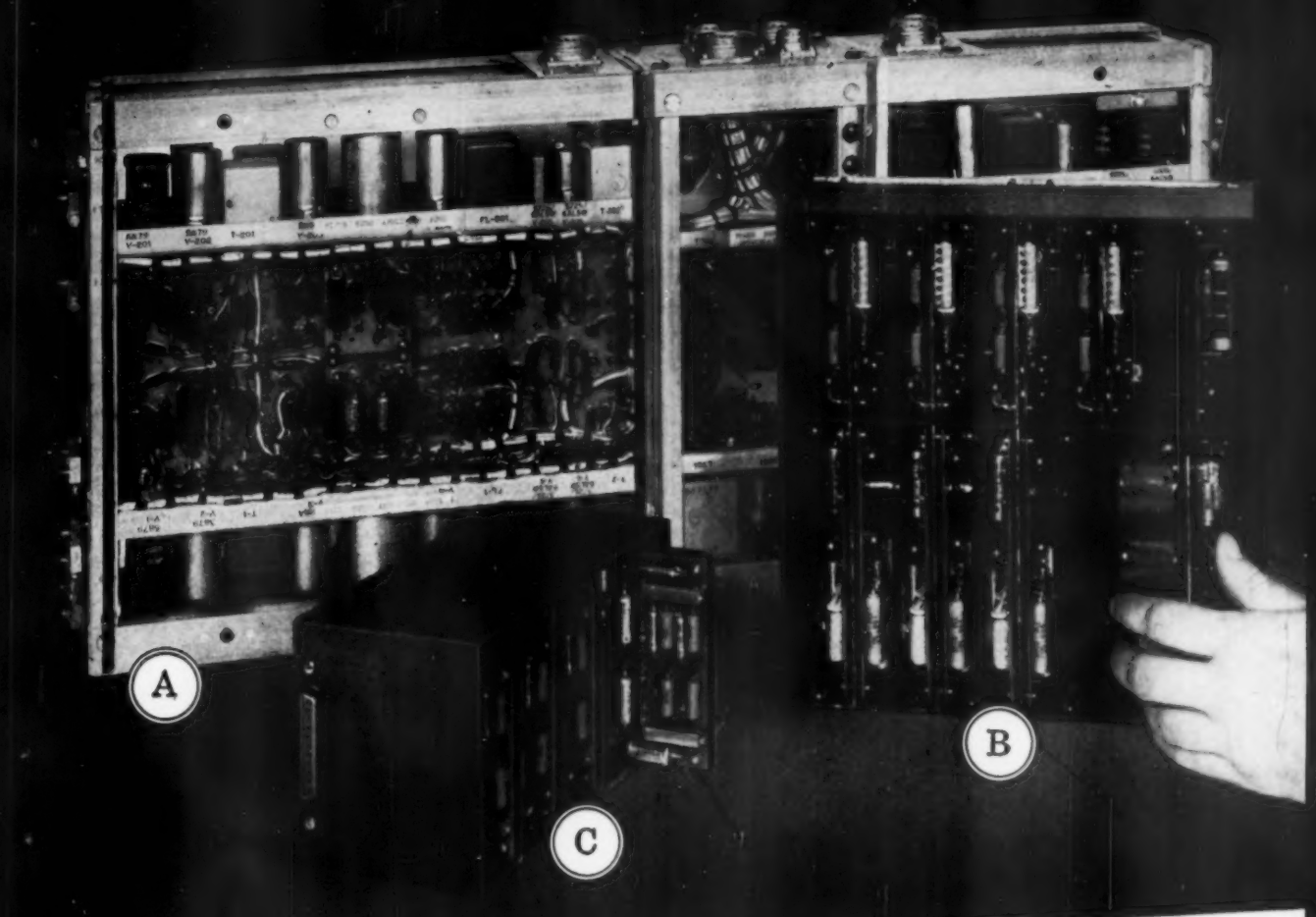
Getting back from a 325-mile-high orbit to a stable 60-mile-high orbit takes about 65 pounds of propellant for a 1,250-pound satellite. Cook Research Laboratories then suggests that the descent to the surface can be made by application of additional thrust, increasing the drag area, or generation of lift and induced drag. Avco proposes a stainless-steel umbrella-type drag brake for a satellite which offers a 20 to 1 variation in drag. The system would weigh 500 pounds and would allow the return of a 2,000-2,500-pound satellite from orbit. This compares with the 1,100-pound retro-rocket system to be used in Project Mercury.

Aerodynamic stabilization of attitude for a satellite orbiting below 300 miles might take the form of a trailing balloon or even a rudder. Douglas Aircraft proposes this method.

Additional details have been released by General Electric Company concerning ablation and heat-sink nose cones. The nose cones provide thermal protection for warheads of ballistic missiles as they reenter the atmosphere and streak toward their targets. Typical speeds encountered are Mach 24 with gas temperatures of 13,000 Fahrenheit. Heat transfer to ballistic missiles is around 2,000 B.t.u. per square foot of nose-cone area. Now in production for the ICBM's are nickel-plated copper cones. The Jupiter missile, however, uses a plastic nose cone that burns away gradually in layers.

Missiles.—Methods for countering hostile ICBM's are being studied by ARPA under Project Defender with allocations near $208 million. Biggest push is the Nike Zeus antimissile rocket missile. The Zeus system might be ready by 1963 if the go-ahead is given now. However its effectiveness has been questioned, and other "blue-sky" proposals are being sought. These include electromagnetic ("disintegrator" or "death-ray") beams, antigravity, shielding, and satellite countermeasure systems. Total cost for the Nike Zeus system has been estimated at over $5 billion, though to date only a few millions have been spent on it.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.



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Above are three stages in development, showing Stavid advances in high density packaging. Result: less cost/volume/weight.

Unit A, a portion of a guidance system developed in 1955, was redesigned by Stavid in 1958 to adapt it to mechanized assembly techniques. Although no attempt was made at miniaturization, Stavid achieved a 70% volume reduction and a 60% weight reduction—and added *a regulated power supply.* (Unit B). Unit C is the package, miniaturized through the use of solid state components.

As a result of years of experience in designing for semi-automatic and mechanized assembly, Stavid has developed an important capability . . . that of reducing volume, weight and production costs . . . and at the same time providing greater reliability, producibility and maintainability in all types of electronic equipment, including the most sophisticated systems.

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F. T. POLITICA, Special Projects Engineer, has specialized in the development and evaluation of electronic equipment, utilizing mechanized assembly techniques. He is presently engaged in a program of miniaturization involving complex missile systems.

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ARMAMENT ELECTRONICS

W. H. Van Vliet

Height-Finding Radar.—The Federal Aviation Agency, at its experimental center at Atlantic City, N. J., is installing an air height surveillance radar (AHSR-1) employing a 150-foot, 3-sided antenna. This antenna will provide height information on commercial air traffic within a range of about fifty miles. The W. L. Maxson Corporation of New York is developing this system, and prototype delivery is scheduled for late 1960.

Soft Lunar Landing.—Wright Air Development Center is developing a flight-control and guidance system suitable for soft landing on the moon. A development contract recently was awarded to Sperry Gyroscope Company by the Air Force for study and development purposes.

Analog Flight Display.—The contact analog flight display system being developed jointly by the Army and Navy to further the use of advanced ideas in the long-range Army-Navy Instrumentation Program (ANIP), soon will be flight-tested in the Navy's Air Development Center at Johnsville, Pa. This new system, the contact analog flight display, provides the pilot with a 3-dimensional view of his aircraft's course along visual cues which establish velocity, rate of turn, altitude, and approach. The aircraft itself will be symbolized by a conventional marker, and the flight-path visual cues and the earth will be displayed in reference to the aircraft symbol.

This device, a logical step toward fulfillment of the more ambitious ANIP, will aid man in tighter control of the aircraft during visual flight as well as during instrument flight. The device also will provide common information which will direct the aircraft toward a predetermined target or landing situation. The tightening of the man-machine loop will make for more effective and safer flight under instrument conditions.

In addition to the analog presentation of visual cues, a radar system is being developed and tested by the Bell Helicopter Corporation for the ANIP. The system will be used primarily in helicopters and will furnish an instrument capable of providing obstacle information close to the ground in all weather conditions, allowing helicopters to be flown in rugged mountain areas and in low-altitude operations during bad weather.

This system will operate over a range of about ten miles for ground mapping and up to five miles for obstacle clearance. The radar antenna will mount on the top of the helicopter in a radome. The display of this system will feed into the vertical situation display which will give a picture of the terrain similar to that shown on a planned position indicator.

Satellite Radar.—The National Aeronautics and Space Administration has as a goal a meteorological satellite equipped with radar to measure weather conditions around the globe. The strength of a radar echo return will give an indication of magnitude of weather conditions which would be very promising for weather prediction on a global basis.

Near Misses.—The Navy's Bureau of Aeronautics is sponsoring development of a new system for measuring relative velocity, trajectory, and distance by which a missile or projectile will pass a drone target. The system, being developed by Aerojet General, is called Firetrac and operates in the VHF band. The airborne part of the system, which weighs about twenty pounds, will be installed in a drone, and data derived from the system's computations will be telemetered to ground stations. It is reported that it will be used in Navy and Air Force target system programs.

RF Radiation Hazards.—The National Institute of Health recently experimented with exposure of experimental animals to high-intensity radio waves. Close-range exposure of the brain of a monkey to UHF radiations from a relatively low power ground transmitter can cause convulsions and death after about five minutes.

Rome Air Development Center has been doing considerable experimentation in this field, and it has been known that internal body temperatures can be raised by exposure to high-intensity radar. Those portions of the body having adequate blood cooling are not seriously affected; however, other portions of the body having nominal blood cooling may suffer serious damage, such as the eyes and other organs. Rome Air Development Center has recently issued a document setting forth safe limits of radiation and a formula establishing safe distances.

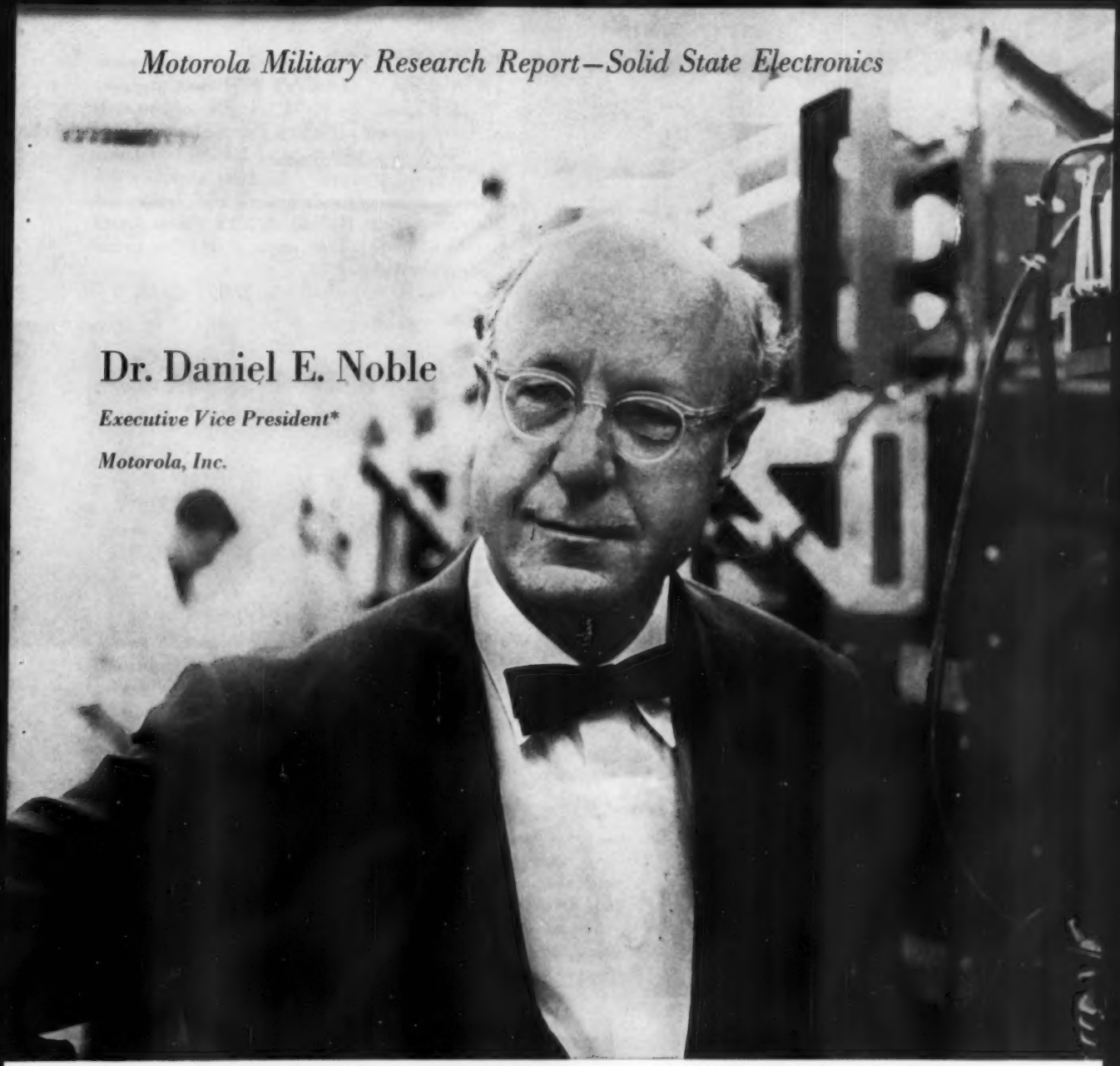
Solar Cells.—A high-efficiency silicon solar cell has moved from the development stage into production without any loss in energy-conversion efficiency. The Semiconductor Division of the Hoffman Electronics Corporation is manufacturing these devices which will convert about ten per cent of the sun's energy striking the silicon cell directly into electricity. These cells will be used to power electrical guidance and communication systems of satellites and space-probe vehicles. It is anticipated that use of solar cells will become widespread in the future as power generators.

Radiation Gap.—The Van Allen radiation belt which encompasses the earth has some gaps between the inner and outer layers which have been inexplicable until recently. Partial explanation of this gap in the radiation belt has been offered by Lockheed Aircraft Corporation. It is believed that this phenomenon is due to the Capetown Anomaly—a weak spot about 1,000 miles long and 300 miles wide in the earth's magnetic field near the southern tip of Africa. It is believed that the Van Allen radiation particles, as they reflect back and forth into the earth's magnetic field, penetrate or fall into this weak spot and are absorbed by the atmosphere, thereby causing the radiation-free gap in the radiation belt.

Sun Pictures.—The Office of Naval Research, by means of a specially developed camera and film mounted in an Aerobee-Hi rocket, recently obtained detailed photographs of the entire sun. These photographs, using the ultraviolet radiation originating in the outer portions of the solar atmosphere, were taken at an altitude of over 123 miles.

Ion Engine.—The National Aeronautics and Space Administration's Lewis Research Laboratory will soon test an ion engine producing about 40 kilowatts of power and about 0.1-pound of thrust.

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.



Dr. Daniel E. Noble

Executive Vice President*

Motorola, Inc.

*DR. NOBLE IS VICE PRESIDENT IN CHARGE OF THE COMMUNICATIONS AND INDUSTRIAL ELECTRONICS DIVISION, THE SEMICONDUCTOR PRODUCTS DIVISION AND THE MILITARY ELECTRONICS DIVISION OF MOTOROLA, INC.

"In this new era, Solid State Electronics will spread its influence to every form of human endeavor and will contribute substantially to scientific achievement in all fields."

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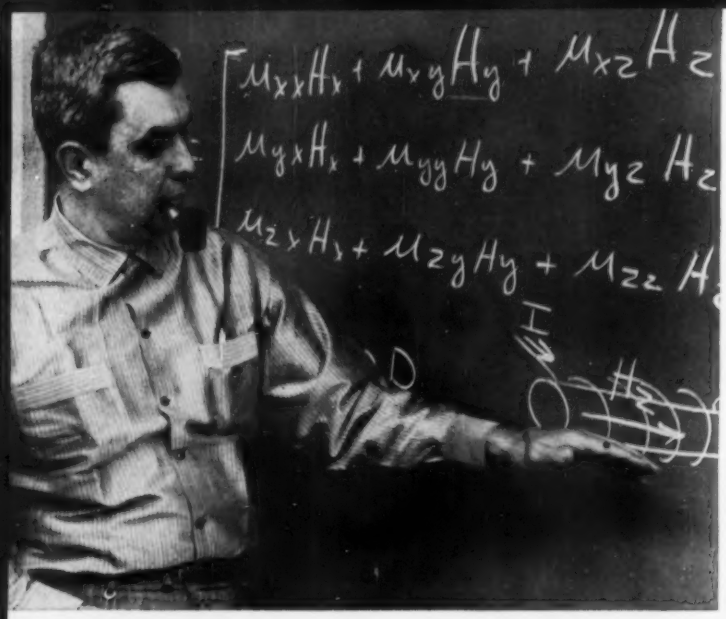

Ferrimagnetic principles are demonstrated by scientist in charge of Motorola's Solid State program, Dr. H. William Welch, Jr., director of research and development, Military Electronics Division. Dr. Welch as a University of Michigan professor established that school's Solid State laboratory and introduced new curricula in Solid State devices and their applications. He holds an I.R.E. Fellow Award for contributions to development of solid state devices and microwave tubes.

Typical of solid state materials now being offered for sale by Motorola are these ferrite rods and bars being examined by Donald L. Fresh, manager of the Solid State Materials Laboratory.

John C. Cacheris, right, manager of the Microwave Applications Laboratory, and a member of his staff inspect a parametric amplifier, one of several devices now being produced by Motorola's Solid State Dept.

Imaginative leadership plus the most modern of laboratory facilities have helped foster a creative environment that is attracting top talent to Motorola. Here, Dr. Arthur L. Aden, associate director of research and development for Motorola's Military Electronics Division, shows a new member of his staff equipment for photographing printed circuits. Dr. Aden welcomes inquiries from qualified engineers and physicists who would like to join his department.

James R. Black, manager of Motorola Microelectronics Laboratory, heads work which leads toward the mass production of economical microelectronic components so small that several would fit on the period that ends this sentence.

How Solid State Electronics is shaping the future

MILITARY ELECTRONICS—industry as well—is being radically changed by rapid advances in solid state technology. Predicted for the near future are computers small enough to fit in the palm of a hand, receivers that will detect the weakest signals from distant satellites.

Motorola's highly experienced Solid State Department, in close cooperation with the Semiconductor Products Division, is advancing the state of the art on several fronts, one of the most promising of which is microelectronics.

By making use of crystalline functional circuit elements created in volume quantities by surface etching or film deposition methods, Motorola researchers anticipate they will soon be able to design equipment with component densities of tens of millions per cubic foot.

This high density will result in a great reduction in systems and computer size coupled with a significant increase in reliability, and it will lead to the development of self organizing computers for such complex tasks as the solution of military logistics problems and space guidance.

In microelectronics and in other areas, Motorola scientists, including those of the Semiconductor Division, are investigating the ferroelectrical, ferrimagnetic, piezoelectrical and pyroelectrical characteristics of monocrystalline and polycrystalline solids. New materials possessing these useful characteristics are created and produced in the Materials Laboratory. Typical applications: newly developed ferroelectrical or piezoelectrical materials to be used in transducers for submarine detection.

At present, the Applications Laboratory is making extensive use of ferrites and semiconductors in the development of broad lines of isolators, circulators and parametric amplifiers. The latter device has already demonstrated its worth in satellite-tracking radars, IGY research receivers, uhf television receivers and radio. In the study and design stage are new and advanced ferrimagnetic devices such as microwave switches, ferrimagnetic limiters and semiconductor switches.

Still another research frontier where striking preliminary results have been achieved is a low-voltage facsimile paper for the transmission of teletype and other information. Applications in the fields of combat surveillance, logistics control and other important military programs are foreseen.

Military Electronics Division's expanding capability in solid state electronics is described in a new booklet entitled: "Solid State Frontiers at Motorola." *Request your copy from Technical Data Service, Motorola, Inc., Military Electronics Division, 8201 East McDowell Road, Scottsdale, Arizona.*

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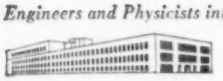

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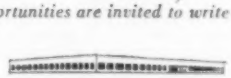

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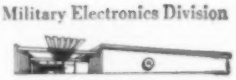

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SPACE ARMAMENT

Stabilized Nose Cone

On July 24, 1959, an Air Force Thor IRBM nose cone achieved the first known fully stabilized space flight controlled in all three axes. The stabilization was confirmed by a 16-mm. camera which took movie footage of the earth from a height of 316 miles and a fully instrumented telemetry system which relayed information back to Air Force tracking stations along the Atlantic Missile Range.

Using the most advanced control equipment, the General Electric-built reentry vehicle took fixes on the sun and on the earth's horizon to lock itself automatically into a completely stable position during the flight through space.

Stabilization of the vehicle was achieved by two infrared sensors and a sun detector which cross-correlated stellar and earthbound coordinate points. The sensors aligned the vehicle between the two opposite horizons of the earth 90 degrees apart for stabilization on the pitch (up and down) and yaw (back and forth) axes. The sun detector completing the third axis spin then went into a programmed scan for fifteen seconds before locking onto the sun.

Both the sensors and the detector fed their information to a central computer within the vehicle; the computer in turn controlled six pneumatic jets which corrected the course of the vehicle to the desired stabilizer axis. It took approximately 280 seconds after separation from the Thor booster before the reentry vehicle was fully stabilized.

The infrared sensors operated on the principle that there is much infrared light radiated from the earth, but very little from space. When the sensors picked up a combination of high and low readings the computer knew that it was aligned with the two horizons of earth. Deviation from this position was reflected in the infrared readings, and the computer activated the compressed-gas jets to realign the vehicle.

The sun detector which eliminated spin from the flight of the vehicle focused the rays of the sun on special heat-sensitive materials whose electrical resistances change when exposed. When the vehicle started to spin, the detector turned away from the sun and the voltage changed. Again the computer instructed the jet nozzles to correct the situation.

Movie film taken from the reentry vehicle was contained in a capsule which was ejected just prior to impact. It was recovered off the island of Antigua, marking the fifth consecutive recovery of data capsules by the Air Force.

Satellite Interceptor

A $600,000 contract calling for a detailed study of a satellite-interceptor system has been awarded to the Radio Corporation of America by the Advanced Research Projects Agency of the Department of Defense.

As part of ARPA's Project Defender, this will be the first comprehensive investigation of a defense system capable of dealing with possible hostile satellite vehicles and is expected to provide the information required to design a system which would become operational during 1965-1970.

The RCA contract was awarded following a detailed technical evaluation by ARPA of general satellite intercept studies performed both independently and under Government sponsorship. If the RCA study proves that such a system is feasible it is expected that competitive bids will be requested for further research and development.

Communications Satellite

Three contracts for the design and development of a delayed-relay communications satellite, to be known as Project Courier, have been awarded by the Army Signal Corps for the Advanced Research Projects Agency. Firing of a satellite to test the capability of Project Courier is expected to take place within a year and at a relatively low orbit of 500 miles.

Philco Corporation, Philadelphia, Pa., was awarded a $3,614,415 contract for the communications package; International Telephone and Telegraph Company, Nutley, N. J., received a $4,046,119 contract for the ground-based communications stations; and Radiation, Inc., Melbourne, Fla., was awarded a $1,283,740 contract for the ground-based antennas.

Project Courier is planned as a delayed-relay communication package aboard a 500-pound satellite, designed to transmit and receive as many as twenty 100-word-per-minute teletypewriter messages between two or more ground-based stations.

As the satellite passes over or near a ground station, plans call for messages to be transmitted to the satellite relay, where they will be stored on magnetic tape. Later, when the satellite arrives over or near the ground station to which the message traffic is addressed, that ground station will trigger the satellite relay with a command signal.

Simulated Space Flight

Volunteer Air Force pilots have been carefully screened and a group selected from which two men will be drawn for the first U. S. experiment in long-term simulated space flight. The Department of Astroecology of the Air Force's School of Aviation Medicine plans to confine the two volunteers in a space-cabin simulator for a period of thirty days.

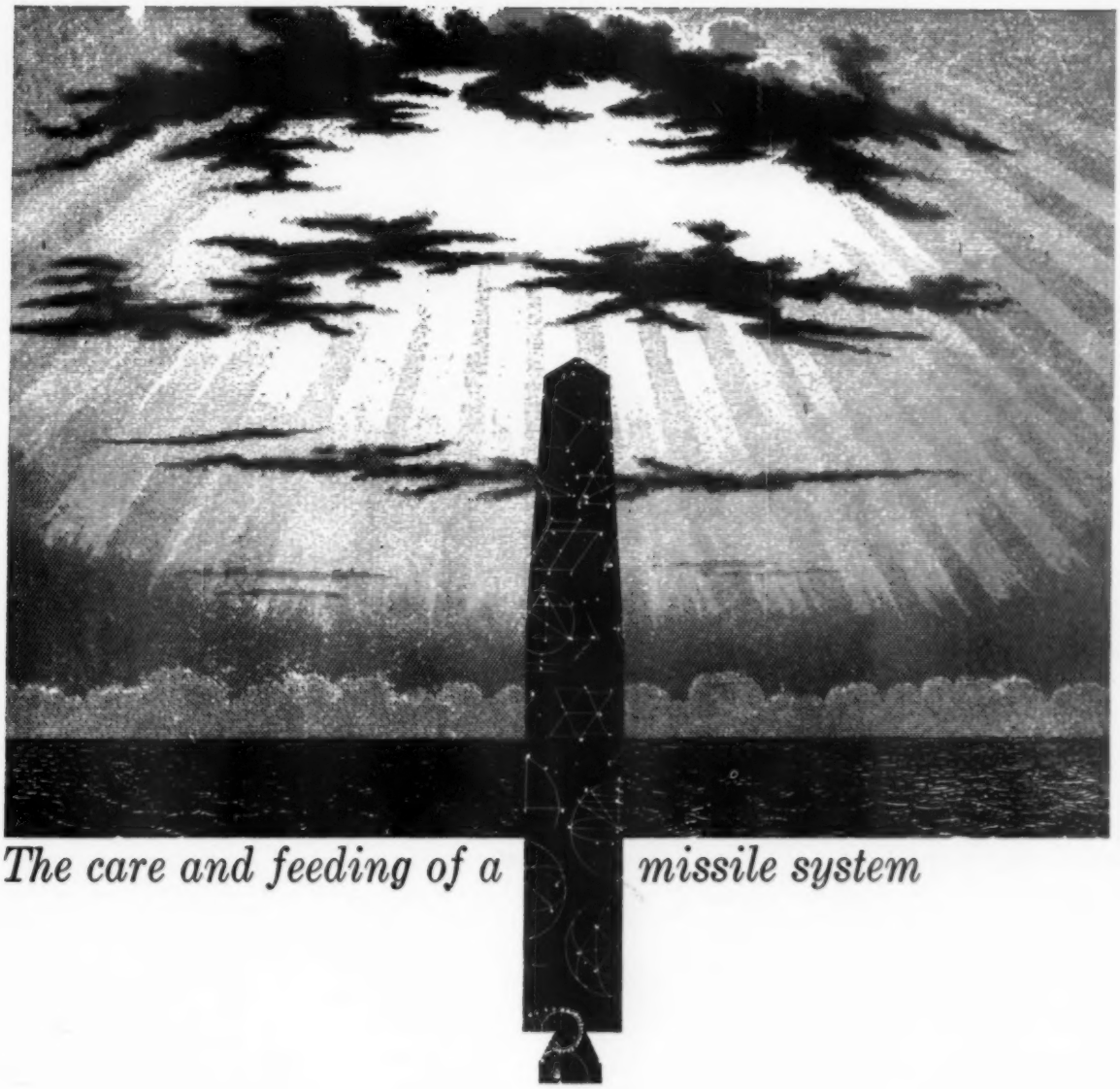
The simulator, a 7-ton device 8 feet high and 12 feet long, is now 90 per cent completed at Minneapolis-Honeywell's Aeronautical Division plant in Minneapolis. As soon as the equipment is thoroughly tested and operators are trained in its use, the first 30-day experiment will be conducted to record psychological and physiological stresses on men in space.

Despite the physical problems of living in cramped quarters for an extended period, space-medicine researchers expect the greatest stresses to be psychological.

As a result of technical developments, the astronauts will be able to breathe and rebreathe the same air and drink and redrink the same water. Solid wastes will be dehydrated and burned in an incinerator and the gases produced disposed of with an afterburner. All that remains from this process is a small amount of fine ash.

A complex system of controls automatically pumps in oxygen when needed, reduces carbon dioxide through the use of chemical absorption beds, pumps in nitrogen if required, and catalytically filters carbon monoxide. Food for the simulated trip will be nonperishable, so refrigeration is not required, but a heating element will be provided to warm up soup and coffee. Cabin pressurization can be varied within a range of sea level to 28,000 feet.

For their daily needs the space travelers will be allotted two quarts of water and 3,000 calories of food. They will have two cubic feet of space, about the size of an overnight bag, to store their clothes and about two cubic feet of storage space for personal belongings.



The care and feeding of a missile system

It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. The wide experience of Douglas in producing large rocket systems has provided the company with unmatched capabilities in this field.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of DOUGLAS

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

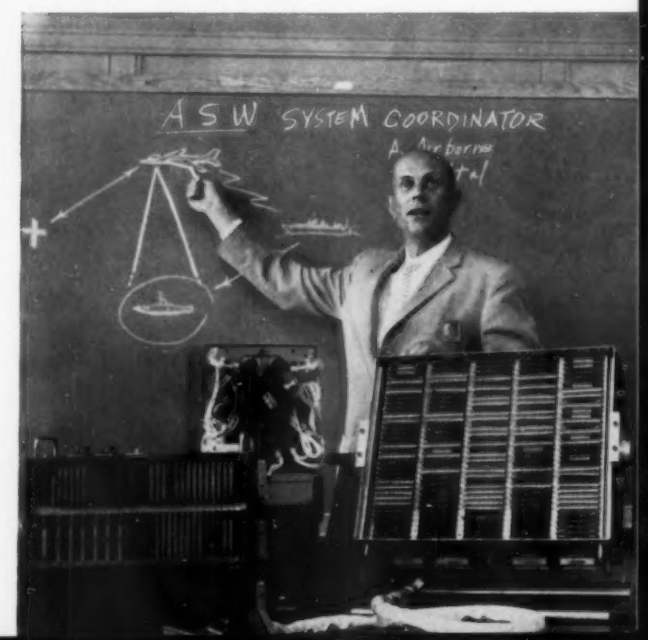
CAPABILITIES FOR DEFENSE

FROM THE SEA COMES A MAJOR THREAT...

A BROAD WESTINGHOUSE

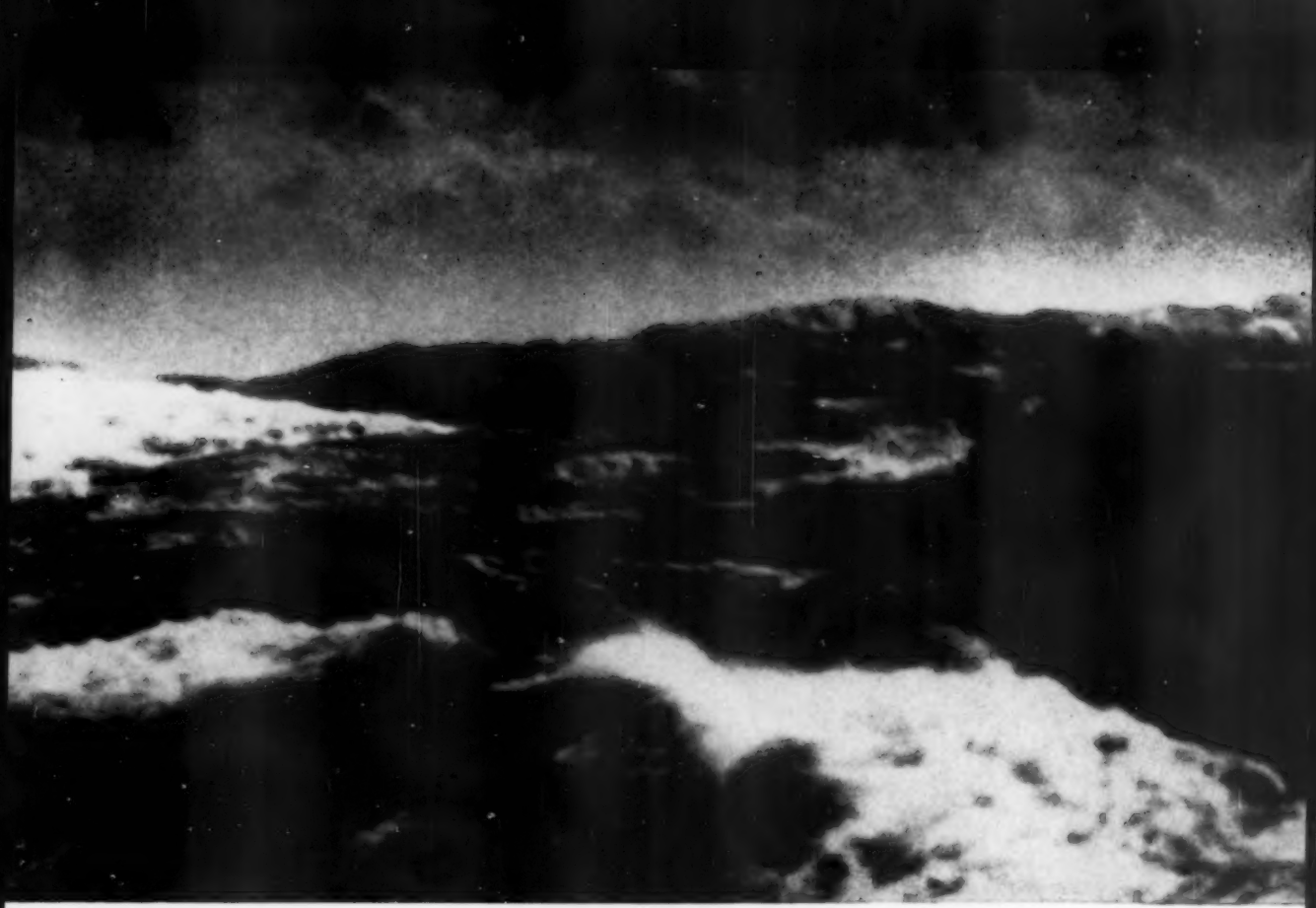
IMAGINATION: Westinghouse developments in scanning systems, cells and special circuitry make possible detection of submarines in a tactical environment.

Developments in computer techniques and components provide the means for fully integrated ASW weapon systems, assuring early detection and sure kill. Typical is this new digital computer from the Westinghouse **AIR ARM DIVISION.**



The environment of the sea favors the submarine. This makes antisubmarine warfare—from detection to kill—one of the most formidable tasks faced by the U. S. Navy. Missile-firing nuclear subs further complicate this acute defense problem. ASW calls for all the imagination, skill and resourcefulness that industry, in its assisting role, can bring to bear.

Westinghouse is engaged in a program to help our forces deal with this increasingly urgent challenge. The corporation's facilities—from research laboratories to manufacturing divisions—are working to help solve this threat.



ASW PROGRAM IS HELPING TO MEET THIS MENACE

SKILL: New radar equipment is in the design and test stage at the AIR ARM and ELECTRONICS DIVISIONS. These Westinghouse radar developments will add effectiveness to ASW search and detection operations in a manner and to a degree never before achieved.

The precision-guided ASTOR torpedo system, provides a powerful weapon in effectively attacking enemy submarines. The ASTOR was designed and built for the Navy by the Westinghouse ORDNANCE DEPARTMENT.

RESOURCEFULNESS: From Westinghouse RESEARCH LABORATORIES comes special knowledge needed for the ASW program. An example is fundamental work aimed at understanding underwater sound "scatterers."

Westinghouse

DEFENSE PRODUCTS

1000 CONNECTICUT AVENUE, N.W., WASHINGTON 6, D.C.

AIR ARM DIVISION
AVIATION GAS TURBINE DIVISION
ELECTRONICS DIVISION
AIRCRAFT EQUIPMENT DEPARTMENT
ORDNANCE DEPARTMENT
WASP

YOU CAN BE SURE... IF IT'S Westinghouse

Texas Instruments roof prism—viewer for photographic system used in the Douglas A3D-2P—helped photo map the landing flight path for North American's X-15

ROAD MAPPER FOR THE X-15

Texas Instruments roof prisms **share a vital role in mapping a safe landing course for the first manned space craft. Installed in a photographic system aboard a Douglas A3D-2P, these prisms recorded landmarks that will guide the X-15 pilot in his return to earth. Accurate photo mapping at 600 miles per hour requires exceptionally high quality optical components. This roof prism, for example, has angles that must be held within seconds of arc. Difficult to manufacture? Not for TI craftsmen... tolerances such as these are met everyday at TI in production quantities.**

Leading designer and producer of silicon, germanium, quartz and other optics for military and commercial uses, TI has intimate familiarity with unusual materials suited to specific portions of the spectrum. In one of the nation's best equipped facilities, TI craftsmen grind, polish and coat precision optics with the same care that goes into a "road mapper" prism. This team — backed by a full-time engineering service and high-speed computers — can meet *your requirements in any quantity* from idea to completion. For detailed information about this technology, send for booklet "Precision Optics at Texas Instruments" or contact SERVICE ENGINEERING:

TEXAS INSTRUMENTS
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DALLAS 9, TEXAS

RECENT PATENTS

Compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents.

Flash Suppressor.—*U. S. Patent No. 2,870,679. Issued January 27, 1959, to Richard V. Collins. Assigned to the Secretary of the Army:* This invention provides a one-piece, quick-attachable flash suppressor for guns or other devices having flaming exhausts. The size of the device is such that it does not obscure the field of vision of the gunner.

Cartridge Ram Link.—*U. S. Patent No. 2,870,682. Issued January 27, 1959, to Charles R. Bell, Eugene S. Wassel, and Mitchell J. Shoelson. Assigned to the Secretary of the Army:* This invention pertains to links for ammunition belts including primers for percussive ramming. In such links presently in use, the cartridge primer is exposed to the ignition of the link primer with consequent danger of premature discharge of the cartridges. The present invention avoids the danger of premature discharge.

Gas Actuating System.—*U. S. Patent No. 2,870,685. Issued January 27, 1959, to Earle M. Harvey. Assigned to the Secretary of the Army:* This invention relates to actuating systems for automatic firearms which are energized by gases bled from the firearm barrel. With conventional gas systems for firearms, parts of the actuating system are mounted to the barrel along its front portion and are actuated by gases bled from the barrel before the projectile leaves the bore. Gases act against the actuating parts with a terrific impact, however, producing vibrations in the actuating mechanism which are transferred to the gun barrel, even though rigidly mounted. This causes inaccuracies in the aim of the firearm.

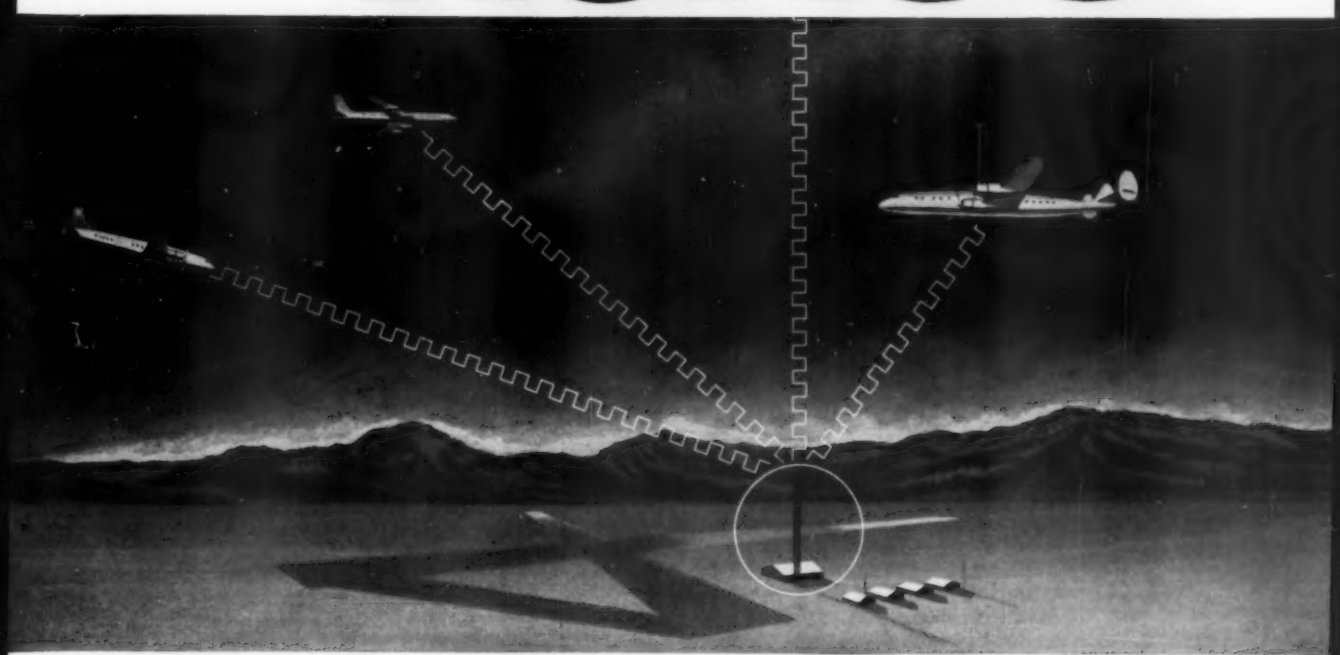
In the present invention, this difficulty is avoided by providing a gas-operated actuating system in which none of the parts is moved until after the projectiles of the exploded cartridges have left the muzzle of the barrel.

Decelerating Device for Air-Dropped Cargo.—*U. S. Patent No. 2,872,138. Issued February 3, 1959, to Richard Vogt. Assigned to the Aerophysics Development Corporation:* Conventionally, cargo is dropped from airplanes by the use of parachutes. Since the required parachute

new wings for words

AGACS

pronounced "AJAX"



AGACS, Experimental Automatic Ground/Air/Ground Communication System is a new concept in Air Traffic Control Communications to meet the accelerated pace of increased air traffic. Primary objectives are efficient usage of frequency spectrum, added safety through increased reliability and reduced burden to pilot and controller, and adaptability to all classes of aircraft. AGACS provides compatibility with existing ground and airborne communication equipment, selective addressing of information, and a minimum number of frequency changes during flight. The system utilizes two-way time division data transfer over existing ground and air communication links to provide an automatic, mutual exchange of information. The airborne facilities display to the pilot the last significant Air/Ground and Ground/Air message quantities, while the controller may recall from central memory-storage equipment the last Air/Ground and Ground/Air message quantities for display. The AGACS program is still in the developmental stage. In August, 1959, RCA provided initial models of both airborne and ground equipments for the Bureau of Research and Development of the Federal Aviation Agency for extensive experimentation and flight tests.

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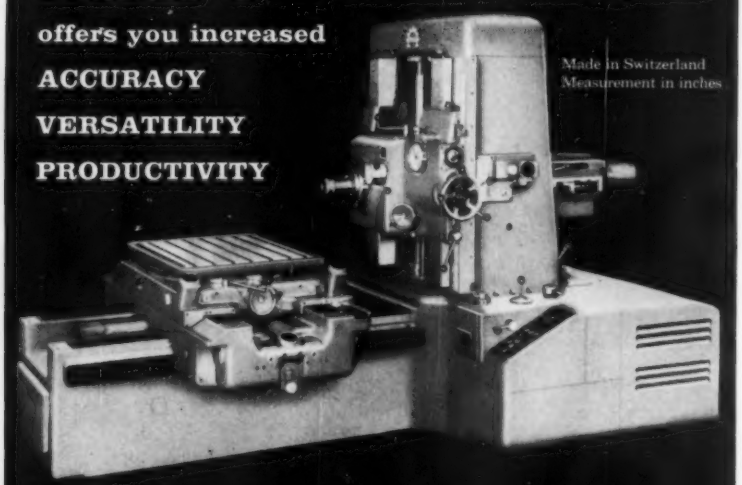

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Recent Patents (Contd.)

size varies inversely with the square of the sinking speed, and inasmuch as it is desirable to minimize the parachute size, shock-absorbing members are generally provided on the underside of the cargo. Such shock-absorbing systems are expensive and result in additional weight.

In the present invention, decelerating means are employed which eliminate the need for shock absorbers. The deceleration system used consists of a standard-size rocket in combination with means for varying the thrust of the rocket so that it may be used effectively under different conditions.

Guide for Fin-Stabilized Ammunition.—*U. S. Patent No. 2,872,864. Issued February 10, 1959, to Gladeon M. Barnes and Nelson R. Droulard. Assigned to the Secretary of the Army:* This invention relates to spin-stabilized fixed-round ammunition of the type used in breech-loaded artillery weapons. The object of the invention is to provide a substitute for guide rails which will not require such precise machining. This is accomplished by providing a center guide which fits into a bore in a specially constructed tail for the projectile and which will remain with the cartridge case when the projectile is fired.

Proximity Firing Devices.—*U. S. Patent No. 2,872,867. Issued February 10, 1959, to Robert D. Huntoon. Assigned to the Secretary of the Navy:* This invention relates to proximity firing devices utilizing high-frequency radiation and powered by wind-driven generators. Difficulty has arisen in the operation of aerial bombs equipped with such firing devices due to electrical fluctuations or unwanted impulses developed by the spinning propeller of the generator. These impulses make effective control of such firing devices difficult and have resulted in unwanted detonations.

It appears that this difficulty is due either to rapid vibrations of capacitance resulting from bearing play or to the fact that the propeller blades cut the flux lines of an asymmetrical field in the vicinity of the nose feed system. The present invention overcomes these difficulties by providing an improved shielding device which is symmetrical in its mechanical design so that it may be installed on a bomb without impairing its flight characteristics.

Plastic Explosives.—*U. S. Patent No. 2,874,604. Issued February 24, 1959, to Albert Diels and Hermann Orth. Assigned to Pouderies Reunies de Belgique S. A.:* This invention provides an apparatus for molding or shaping plastic explosives such as dynamite into elongated cylindrical rods. The raw explosive material is passed between two grooved rollers having resilient sleeves mounted thereon under tension

ELECTRONIC LIFE PRESERVERS FOR THE MISSILE AGE

They're known as countermeasures.

To you, they could represent the difference between life and death.

Their job: to make missiles miss.

Active countermeasures may jam the radar which guides a missile. Or blind its electronic eyes. Or deflect it from its course. Or help seek it out and destroy it—miles from its target.

They Cannot Wait

If an attack ever comes, there are only minutes in which to act.

ITT is one of the companies holding the stop watch.

More than 15 years ago, in fact, the Department of Defense anticipated missile warfare and assigned the ITT System to the development of countermeasures.

Since then, many have been perfected. Others are now being tested. Still others are being rushed to completion. Some are active countermeasures. Others are passive countermeasures, which record hostile electronic activities.

Hundreds of ITT scientists and technicians, specialists in fields such as physics, astronautics, electronics, chemistry and metallurgy, are devoting their energies to the job.

At their disposal are the facilities of 101 growing research and manufacturing plants.

Many Other Big Jobs

Countermeasure development is one of the many areas in which ITT is engaged for the defense of the United States.

Guiding, controlling and testing missiles—to defend, to retaliate—is another vital area of activity. Still another is the creation of a split-second global communications system for the Strategic Air Command. And the development of earth satellites is another.

The all-important job of operating and maintaining the DEW Line, our Distant Early Warning radar network in the Arctic, is also an ITT assignment.

Countermeasures Come First

The potentiality of missile warfare is a fact we must face squarely, realistically and *quickly*. Countermeasures must be on call. ITT will help to get them there in time.

ITT

. . . the largest American-owned world-wide electronic and telecommunication enterprise, with 101 research and manufacturing units, 14 operating companies and 130,000 employees.

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NEW IDEAS IN PACKAGED POWER

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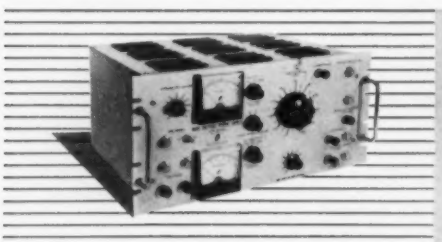


Series 1000.

Easy-to-use compact Beta Series 1000 high voltage supplies come in 13 different models, providing voltages up to 60kv dc and currents as high as 500 ma. Adjustable output voltage (0 to max. rating with coarse and fine controls); extremely low ripple; easy, rapid polarity reversal and full metering are a few outstanding features.

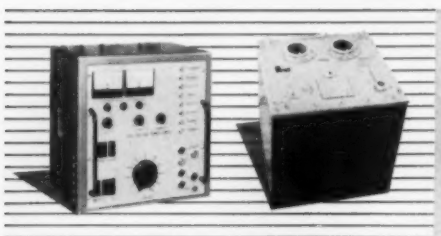
Single-unit, rack-mounting supplies to 60 KV

Available ranges and current capacities:

Output (DC KV)	Current (Max. MA)
0-1	500
0-3	200
0-5	10 or 100
0-10	2, 10, or 50
0-15	5, or 10
0-30	2, 5, or 10
0-60	5 @ 50 KV 1 @ 60 KV

Inputs: 117 vac, 60 cps, single phase

HV DC TO 250KV WITH MAXIMUM CONVENIENCE, SAFETY



Series 2000 — control section (left).
Series 2000 — high-voltage section (right).

Simple to operate, conservatively rated to insure long, optimum performance with maximum safety, Beta Series 2000 supplies come in thirteen different models, with maximum voltages ranging from 1 to 250kv dc. Output voltage continuously adjustable from 0 to maximum. Two-unit design allows optional remote operation of high voltage circuits. For maximum voltages less than 30 kv, the high-voltage unit is air-insulated; for higher voltages, oil-insulated (shipped dry). Every precaution is taken to insure personnel and equipment safety.

Two section supplies to 250KV

Available ratings:

Output (KV DC)	Current (Max. MA continuous)
0-1	3000
0-3	1000
0-6	500
0-10	200
0-20	150
0-30	30
0-30	100
0-50	10, 50
0-120	5
0-120	25
0-150	5
0-250	10

Inputs: 117 vac, 60 cps, single phase

Sorensen markets the widest line of controlled power equipment available today, including: Regulated a-c and d-c supplies, unregulated power supplies, frequency changers, inverters, and converters, SAMES electrostatic generators for regulated voltages up to 600 kv dc, voltage reference sources, high-voltage d-c overpotential testers and high-potential test equipment.

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Recent Patents (Contd.)

so as to mold or compress the material directly into its final desired shape.

Matching Sun Trajectories.—*U. S. Patent No. 2,876,679. Issued March 10, 1959, to Frank W. Dietsch and C. Walton Musser. Assigned to the Secretary of the Army:* This invention provides a mechanism for maintaining, between the barrels of a major and a minor gun, bias or angular relation, such that the trajectories of the two weapons are automatically matched at all elevations of the major weapon so that projectiles from the two weapons always arrive at the same target.

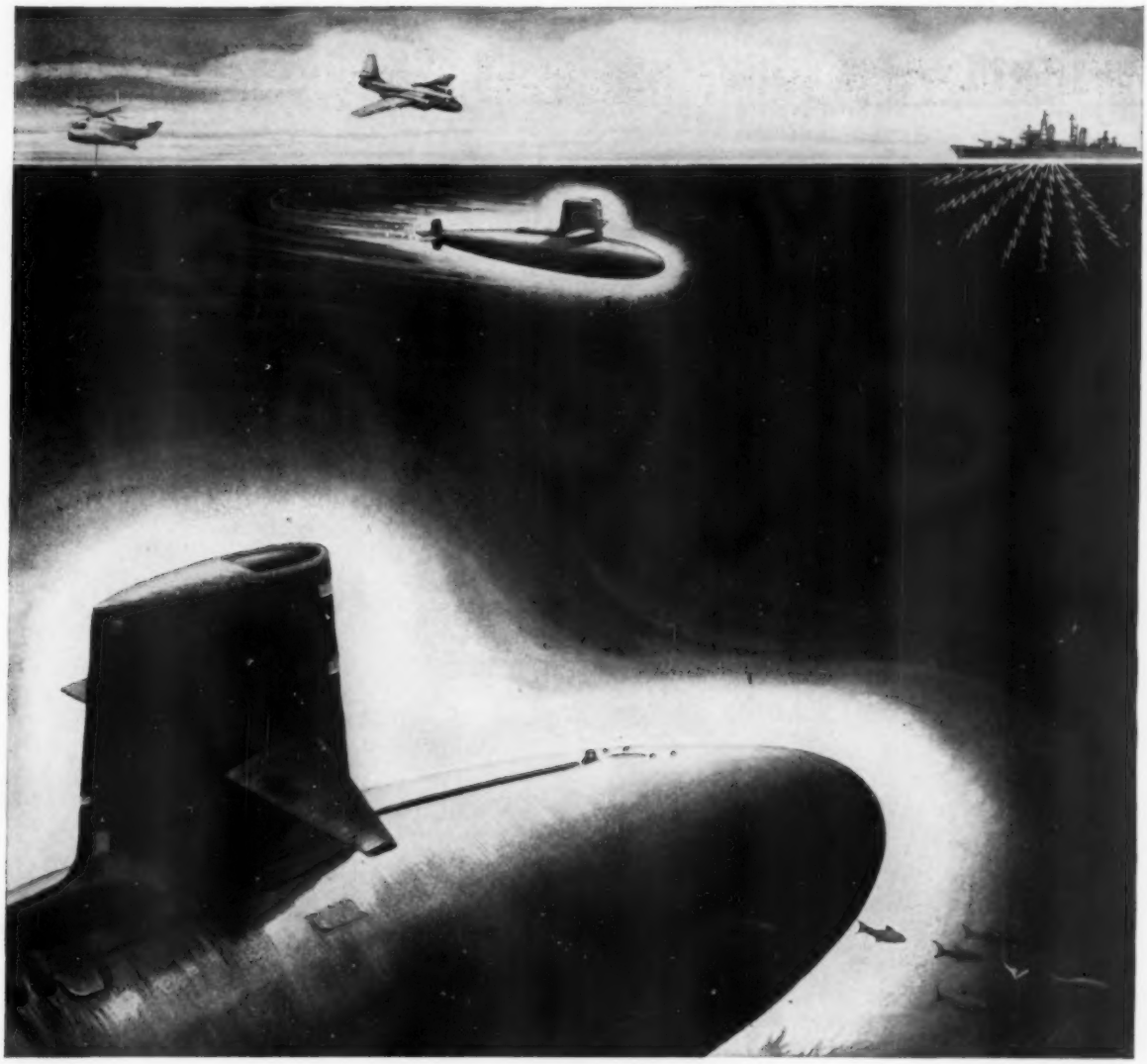
Twin Detonating Fuze.—*U. S. Patent No. 2,877,708. Issued March 17, 1959, to Marcel Rey. Assigned to Rey Freres & Cie.:* This invention provides a detonating fuze of the flexible type which combines in a single fuze two separate explosive charges which are parallel to each other and are enclosed in a common casing.

Aircraft Gun Enclosure.—*U. S. Patent No. 2,843,022. Issued to René W. Bonnette and Robert B. Tassie. Assigned to General Electric Company:* In this invention a new and improved turret housing is provided for aircraft tail guns which is both streamlined and yet symmetrically balanced for all positions of the gun in either azimuth or elevation, thereby reducing the wind resistance and drag on the aircraft.

Floating Mine.—*U. S. Patent No. 2,845,025. Issued to Howard J. Stark:* This invention provides a floating mine which consists of an explosive having a closed-cell cellular-foam structure which is buoyant with respect to water and of greater and more rapid shattering effect than the same weight of high-density explosive. The cellular explosives used have buoyancies of 20 to 50 pounds per cubic foot.

The following explosives can be prepared in foam or cellular form: (1) trinitrotoluene; (2) nitrocellulose (tri, hexa, and dodeka nitrocellulose); (3) pentaerythritol; (4) RDX (cyclo trimethylenetrinitramine). The foamed explosive consists of any one of the above explosives bonded by a thermosetting resin.

Manufacturing Explosives.—*U. S. Patent No. 2,852,360. Issued to Nils. G. By. Assigned to Aktiebolaget Bofors:* This patent relates to a process for manufacturing granulated mixed explosives containing TNT. To lessen the hazard of explosion it is possible to mix the explosives in an aqueous solution, but the TNT is limited to a maximum of 20 per cent. The present invention makes it possible to vary the mutual relationship between the explosives as in the direct-mix method.



Sixth sense for the hunter-killers

"Our greatest need is for longer range detection equipment and the weapons to give us the kill capability by the time we have the extended range search and identification gear."—Rear Admiral John Thach, Commander Anti-Submarine Defense Group ALFA.

The Navy's Special Task Group Alfa—the Hunter-Killers who defend against enemy submarines—must find faster and deadlier means of detecting and destroying enemy submarines in time of war. Submarines launching nuclear warheads could destroy major cities and military installations in a matter of minutes.

ARMA has accepted the challenge to provide for the Navy's greatest ASW need, insuring our future by swifter and surer elimination of the undersea threat.

This and other top-priority projects are underway at ARMA—longtime developer of new concepts and equipment for the American military.

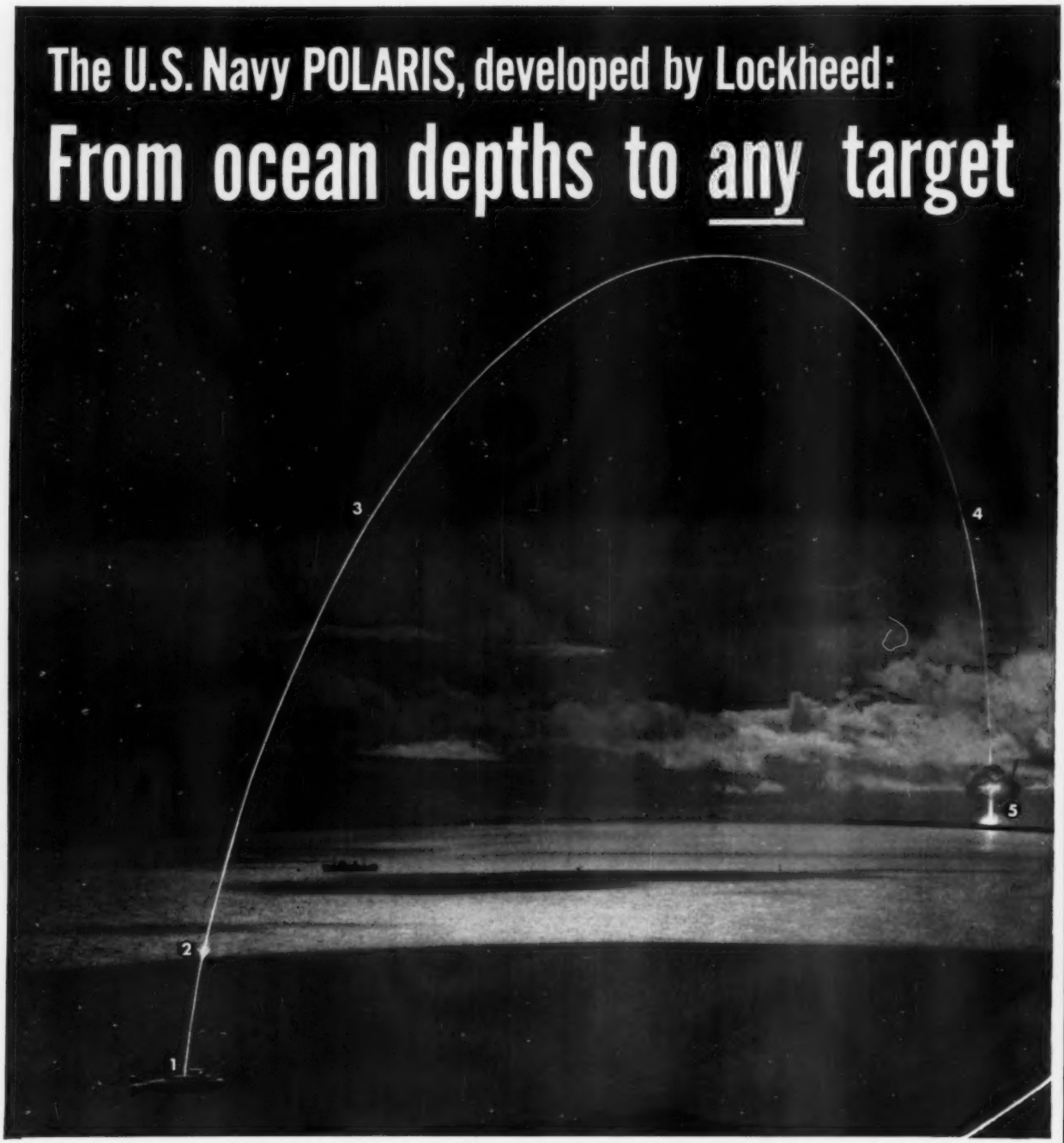
ARMA, Garden City, N.Y., a division of American Bosch Arma Corporation . . . The Future Is Our Business.

6942-A

AMERICAN BOSCH ARMA CORPORATION

The U.S. Navy POLARIS, developed by Lockheed:

From ocean depths to any target



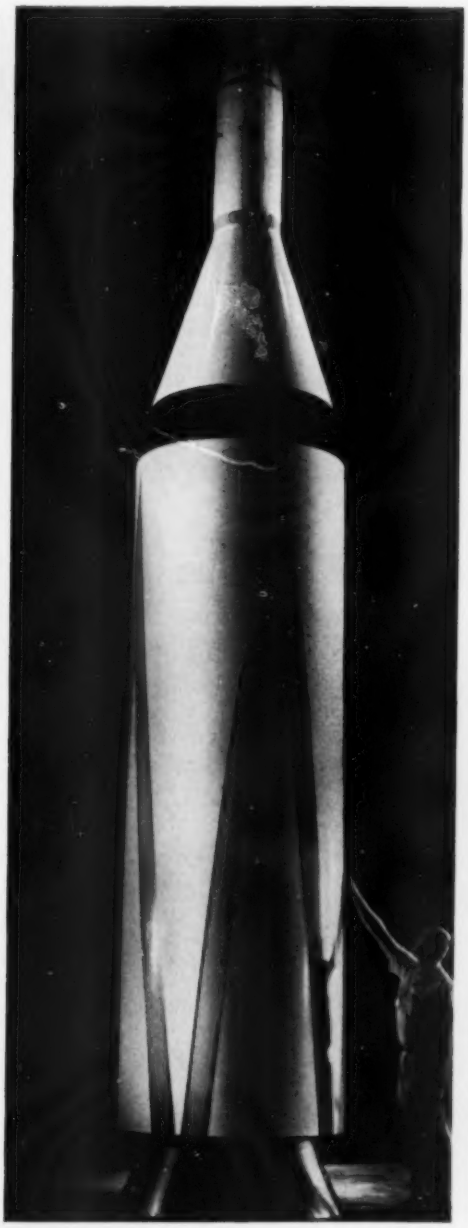
Navy's hidden nuclear submarine (1) launches a solid-propellant POLARIS missile, which erupts from the depths (2), rockets its way into space (3). Plunging earthward minutes later, the warhead of the POLARIS re-enters earth's atmosphere (4) and destroys its target (5).

America can breathe easier next year when the Lockheed-developed POLARIS missile goes to sea aboard the Navy's nuclear-powered submarines—far ahead of original schedule. For every significant military target will be within its ultimate range of 1500 nautical miles.

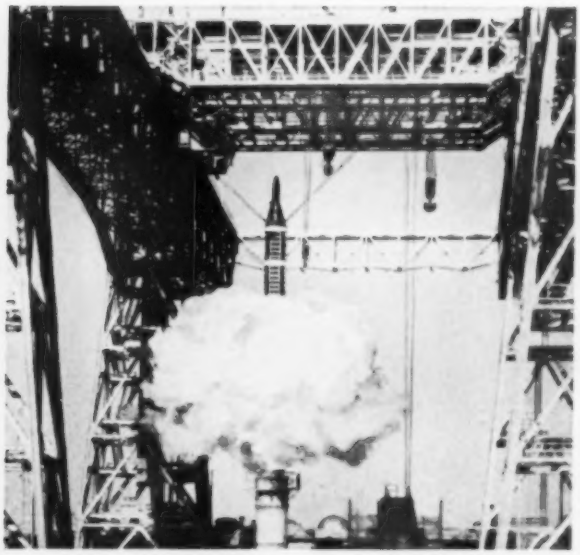
To be an effective deterrent to aggression, a weapon system must be safe from surprise, ready to strike back after any attack. The Navy's POLARIS submarines will be immune to detection as they prowl submerged for weeks at a time. And they'll move the bulls-eye of enemy attack from our soil to the trackless depths of the sea.

Lockheed's Missiles and Space Division is POLARIS Missile System manager and prime contractor—leader of an industrial team that includes Aerojet-General, General Electric, Westinghouse, and hundreds of other contractors and suppliers, large and small. Close cooperation has brought the POLARIS from blueprint to hardware in record time.

This new combination of nuclear submarine and POLARIS missile will round out the nation's arsenal and give us the flexibility we need for adequate defense.



POLARIS is much smaller than other U.S. ballistic missiles of the same range, thanks to new miniaturization techniques developed by Lockheed scientists. This permits each nuclear submarine to carry 16 missiles.



"Operation Sky-Catch" is apt name for this huge overhead assembly. It catches POLARIS test vehicles in mid-air after test launchings. This prevents damage to components and gives more accurate instrument readings, thus saving time and speeding development. Tests are conducted jointly by U. S. Navy, Westinghouse, and Lockheed.

4,000-acre test base in the Santa Cruz Mountains of California is where Lockheed's Missiles and Space Division puts completed POLARIS missiles through simulated flights that prove the propulsion and guidance systems before actual flights of development missiles.

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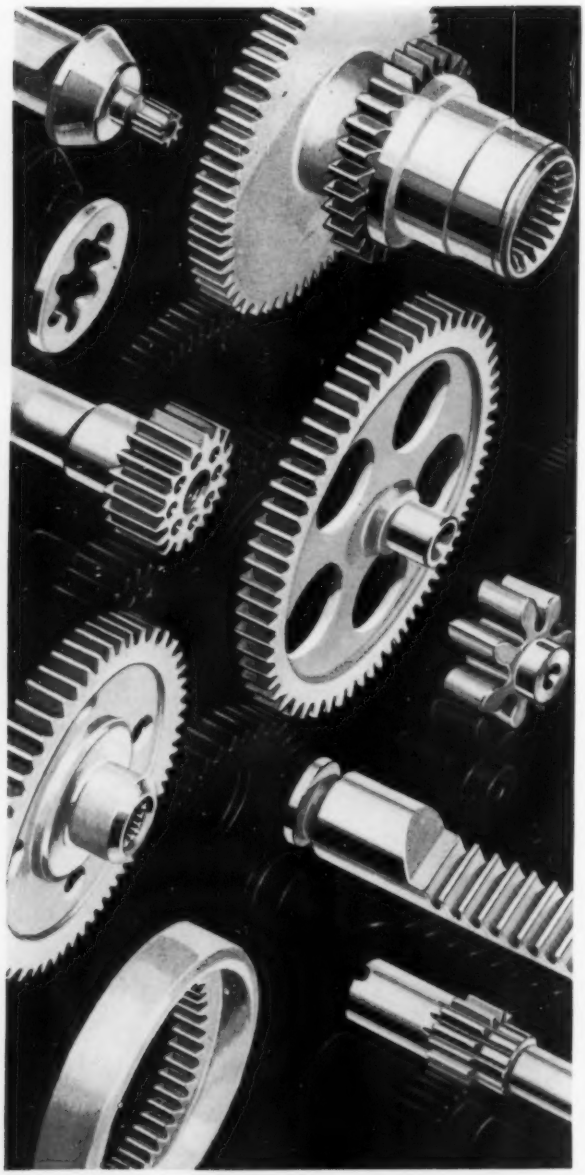

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

LEO A. CODD, *editor, Washington, D. C.*

STANLEY L. FALK, *historian, Joint Chiefs of Staff, Washington, D. C.*

F. W. FOSTER GLEASON, *military historian, ordnance analyst, editor, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

ORVILLE C. SHIREY, *major, Infantry, U. S. Army Reserve, Washington, D. C.*

W. H. RUSSELL, *educator, historian, Annapolis, Md.*

CAPT. J. M. P. WRIGHT, *U.S.N. (Ret.), naval ordnance engineer, logistician, editor, Washington, D. C.*

The Third World War. By Harry Welton. New York: Philosophical Library, Inc. 330 pp. $6.

THE theme of this book is that the Third World War is already in progress and that the aggressions in Korea, Indochina, the Near East, and elsewhere are but a small part of the Soviet long-range plan to communize the whole world. The idea is not new, but the author has assembled an abundance of detailed proof to show that treaties with the Communists are valueless and that there is no such thing as peaceful coexistence between the Soviet system and the Free World.

Coexistence to the Soviet leaders merely means an agreement to refrain from a fighting war until the Communist power is strong enough to impose its will. In the meantime the coexistence period is used to cripple the free nations by penetration of the trade unions and other organizations and by economic pressures.

The word "peace" does not have the same meaning in the Soviet world as it does in the free world. As stated by the Soviet Ministry of Defense: "The surest means of doing away with wars and establishing permanent peace is the overthrow of the power of the imperialistic bourgeoisie."

Thus, any fighting or subversive campaigns against capitalistic nations is "liberation to establish peace" and not war. The author proves by quotations from their own writings that the Russian leaders are determined to win areas and peoples by these methods of "peaceful coexistence" until the time is appropriate to send in their armies. The book is well worth careful study.—GEORGE S. BRADY.

The War Memoirs of Charles de Gaulle—Unity 1942-1944. Translated from the French by by Richard Howard. New York: Simon & Schuster, Inc. 378 pp. $6.

GENERAL de Gaulle personified the spirit of militant France throughout the Second World War, especially during the years

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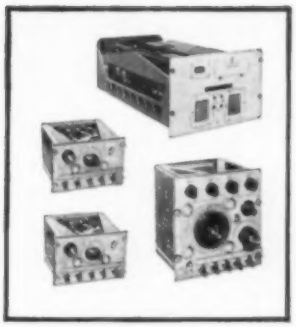

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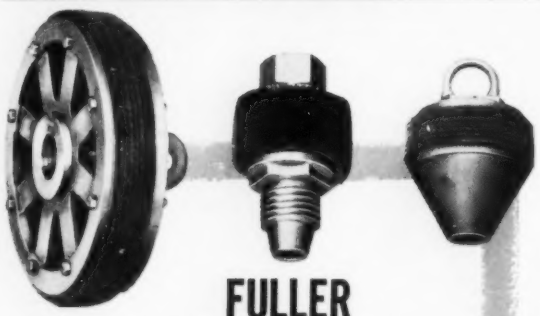

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Book Reviews (Contd.)

when the country geographically was occupied by the enemy and Vichy represented surrender. He has lived to return and reunify his countrymen and to lead them along paths which he hopes will bring them back to their former power.

In this book he recounts with characteristic candor the travail through which he passed in effecting leadership. His encounters with Churchill, Roosevelt, Eden, and others will stand in the annals of military history as examples of the soldier face to face with the politician. So also do his encounters with General Giraud whom the allies regarded to be the true leader of France —so great were their suspicions of General de Gaulle who was the personification of the French Resistance.

"General, you claim to be France," thundered Churchill. "You are not France. I do not recognize you as France."

"Then why," replied De Gaulle, "and with what right are you dealing with me concerning her worldwide interests?"

General de Gaulle's narrative cannot be read without a deep consciousness of the events that have transpired since World War II—even to this hour. His steadfastness again is proving him to be a leader tinged with the greatness that made France high among the nations.

Nor should his achievements prior to 1939 be forgotten. He was one of the first among his compatriots to see and speak for mechanized warfare and to appraise adequately the new element of firepower that mechanization brought to the battlefield. In the areas of tactics in warfare and strategy in diplomacy he was, as this book shows, adamant in holding to first principles while using all modern advancements. He deserves, again as this book shows, sympathetic and helpful admiration for his leadership of France today.—Leo A. Codd.

Challengers of the Deep. By Wilbur Cross. New York: William Sloane Associates. 258 pp. $5.

BEFORE the time of Jules Verne, inventors struggled to perfect undersea craft for military use. This volume recounts all the American attempts beginning in 1776 with Bushnell who built the Turtle to attack British men-of-war in New York harbor.

Many heroic efforts were made to use submersibles in the Civil War but they did not become practicable until the electric battery and the gasoline engine were developed and put to use to power them. Simon Lake was the moving spirit among the early inventors whose dedication paved the way for our modern submarine.

Early accounts of these events, the grim escape and rescue attempts of U. S. Navy submariners who went down, and some of the outstanding submarine actions of World War II are all described in Mr. Cross' well-illustrated book.—J. M. P. Wright.

Education and Military Leadership—A Study of the R.O.T.C. By Gene M. Lyons and John W. Masland. Princeton: Princeton University Press. 283 pp. $5.

PERHAPS the subtitle, "A Study of the R.O.T.C.," does this excellent book a disservice, since it implied, to this reviewer at least, a rather dry study of an educational system that has, traditionally, been "neither fish nor fowl nor good red herring." Instead, Professors Lyons and Masland have delivered themselves of a tightly reasoned study, carefully researched and documented, that drives straight to the heart of the officer-procurement problems of the military services.

The R.O.T.C. system, as most of us who were its products before World War II remember it, produced few officers who were capable of commanding platoons—or much of anything else—without further training in service schools. But it did serve its purpose in assuring a substantial reservoir of college-trained young men (100,000 were available at the beginning of World War II) who could be called on quickly in time of war and who required a minimum of retraining. (*Continued on p. 312*)

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Examples: A method of recovering potable water from human waste fluid, the major source of water in a sealed space vehicle... Methods of analyzing the effects of a nuclear blast on the earth's crust, how it changes the character of soil and rock, how its shock is propagated, what sort of building structure will withstand it... Platforms on which will be mounted primary standards calibration instruments for missile guidance systems. These platforms must be so vibration-free that natural earth movements must be compensated for. Platform vibrations are limited to millionths of an inch ...A method of predicting temperatures in missile nose cones upon re-entry.

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The trouble is, the authors point out, that there is still a tendency to think of the R.O.T.C. program in this frame of reference. They say: "College faculties still think of the programs in terms of substandard courses and close-order drill; college administrators are still concerned with the effect of military obligation on continued enrollment and are convinced that the armed services do not know how to use talent; and many military planners are still thinking in terms of stockpiling manpower. All these attitudes were born in the years prior to 1945."

In fact, however, since 1945 the R.O.T.C. programs of the Army, Navy, and Air Force have reflected a shift from the production of Reserve officers, to the production of active-duty officers serving for stated periods. The prospect now is for a further shift to the production of career officers, a trend that already has been in evidence for some time.

The authors also point out that the change in the nature of war makes it essential that the armed services secure their share of the annual crop of college and university graduates on a career basis. The citizen-army concept is no longer adequate for our military commitments, and the size of the professional defense forces we now have and will have for the foreseeable future requires that the majority of officers for these forces come from civilian colleges and universities.

But, while we are faced with this changed concept as a fact of military life, the only reflection of it in the R.O.T.C. program (or, more accurately, the officer procurement program) has been on a basis of improvisation, and reluctant improvisation, at that.

Professors Lyons and Masland criticize both the services and the Administration for failure to make and implement proper plans recognizing the shift to procurement of career officers.

This volume would make an excellent place for the planners to begin on a really efficient system of officer procurement. It is written from expert knowledge and is thoroughly constructive throughout. Most important, it is a reasonable approach to one of the most critical problems the Defense Department faces in the years ahead. It should be required reading for every officer.—ORVILLE C. SHIREY.

Tiger in the Sky. By Gen. Robert L. Scott. New York: Ballantine Books. 142 pp. 35 cents, paperbound.

THIS collection of stories on Air Force life—both in peace and in war—illuminates the motivation of combat fighter pilots. This book, largely biographical, portrays the inducement for combat indirectly by providing access to the inner thoughts of fighter pilots. Many scholarly works have been written on the personalities and qualities of leadership in top commanders, but our literature is scarce in the portrayal of effective leadership on the level of the individual or unit commander.

The author emphasizes that fighter pilots who are highly competent and successful in combat do not necessarily have the basic qualifications for high command. There is no question that the "tiger spirit" is the key to successful fighter combat. The problem of maintaining this spirit as the pilot matures and accepts larger responsibilities is the challenge given to Air Force leaders by the author of this book.—E. P. MECHLING.

The Soviet Navy. Edited by Comdr. M. G. Saunders, R.N. New York: Frederick A. Praeger, Inc. 327 pp. $7.50.

PAGE for page, this book packs more information about the history, status, and potential of Russian sea power than any other volume available in English. It sketches the rise, fall, and resurgence of Russian interest in strategic use of the sea from before 1700 down through 1956, when Marshal Zukhov warned the Twentieth Communist Party Congress that "in a future war the struggle at sea will be of even greater importance than it was in the last war."

Of particular interest to the general reader will be pages where Dr. R. W. Daly and Dr. Juergen Rohwer show how steady growth of the Czarist navy was checked at Tsushima in 1905, with after-effects painfully apparent until 1945. Other contributors deal with the need in postwar Russia for a navy capable of more than mere coastal defense.

Unfortunately, Commander Saunders and his eighteen contributors from eleven countries do little more than scratch the surface, raise questions, or reveal significant gaps in our knowledge of the Soviet Navy. Even so, their book is an important step toward informing United States citizens about the role Russian sea power can play. If it does no more than draw a few serious scholars into an almost virgin field, this volume will have paid its way.—W. H. RUSSELL.

Daredevils of the Confederate Army—The Story of the St. Albans Raiders. By Oscar A. Kinchen. Boston: Christopher Publishing House. 171 pp. $3.

THE rather odd title of this little volume is symptomatic of the whole. When some twenty-one soldiers conduct a raid at a cost to themselves of three or four wounded, none killed, and a dozen jailed by Canadian police, they are slightly less than "daredevils."

Standing by itself, the St. Albans raid was little more than comic opera in such a tremendous conflict as the Civil War. Netting $200,000, a few houses scorched,

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☐ **TELECOMMUNICATIONS ENGINEERS** – To design and develop advanced communications subsystems of ground electronic control system complex. (EE degree and 5 years' experience)

☐ **PROPAGATION CONSULTANTS**–To assist in the design, development and management of radar and communications subsystems as applicable to an air defense system. (Advanced degree in EE or Physics with 5 years' experience)

☐ **RADAR RECEIVER & VIDEO PROCESSING ENGINEERS** – To establish receiver design criteria for optimum system performance in varied environments, particularly ECM. (Advanced EE degree or equivalent and minimum 5 years' experience)

☐ **ECM SPECIALISTS** – To provide threat models and consultation to design and management engineers. (Advanced degree in EE and 3-5 years' experience)

☐ **ANTENNA AND MICROWAVE ENGINEERS** – To establish antenna design and sighting philosophies for optimised detection system performance. (Advanced EE degree and 5 years' experience)

☐ **RADAR DESIGN ENGINEERS** – To work on advanced designs and development of receivers utilizing parametric amplifiers. (BSEE and 2-4 years' experience)

☐ **PERSONNEL SELECTION AND TRAINING SPECIALISTS** – To prepare job evaluations, manning structures for complex military systems, and forecast training aid needs. (PhD or EdD required)

☐ **EQUIPMENT EVALUATION SPECIALISTS**–To solve man-machine problems, evaluate alternative components, displays, or techniques and devise simulators. (PhD in Experimental Psychology)

☐ **CABLING ENGINEERS** – To resolve varied problems in grounding and associated shielding problems of complex electronics equipments. (EE degree with minimum 2 years' experience)

☐ **LOGIC DESIGNERS** – To organize and perform logic designs of a high speed digital computer. (Degree in EE, Math or Physics with minimum 4 years' experience)

☐ **CIRCUIT DESIGN ENGINEERS (DISPLAY)** – To analyze equipment and circuit design requirements in data utilization and display subsystems. (Electrical Engineering degree with minimum 5 years' experience required)

☐ **SYSTEMS ANALYSTS** – To conduct system analysis programs and feasibility studies which lead to the conception and development of new systems, subsystems, and equipments of advanced design and function. (Advanced degree in EE, Math or Physics preferred with 3 years' previous experience)

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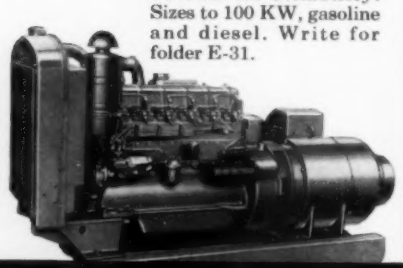

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Book Reviews (Contd.)

and one woodshed burned, immediate results were tiny indeed. Yet terror was widespread and very real. If this raid had been timed to coincide with the New York City fire raid, and both with the "Draft Riots," and if the miserable and untested "Greek fire" had been replaced by a real incendiary agent, great results might have followed. Few people realize how intense and widespread was Confederate sympathy in New York and large sections of the West.

Altogether, it is a rather slight but most entertaining story. —F. W. FOSTER GLEASON.

The Battle of France, 1940. By Col. A. Goutard. Translated from the French by Capt. A. R. P. Burgess. New York: Ives Washburn, Inc. 280 pp. $4.

THE outstanding feature of this book is not the account of the fighting but the documented facts of how a German propaganda bluff of superiority, much like the Soviet boasting of today, was begun in 1936 and by 1940 had frightened the French Command into a state of mental paralysis.

The Siegfried Line in 1939 was also a propaganda bluff. If the French had moved forward while the German "hard core" was in Poland, the whole industrial Ruhr and Rhineland could have been captured with ease. But the French did not move, nor could they leave their concrete bunkers and concentrate their scattered forces to meet the German thrust in 1940.

Allied adherence to a static "defense" policy to gain time gave the Germans eight months to prepare for the 1940 blitzkrieg and then gave into their hands the entire munitions equipment and industrial resources of France and Belgium. The book is an excellent practical study of the value of a small, determined striking power as compared with a big lethargic "defense" complex.—GEORGE S. BRADY.

A.O.A. DIRECTORY AND INDEX

- The Annual A.O.A. Directory for 1959-1960 is now available. It contains rosters of the national Council, officers and directors, and advisory board of the Association. It also shows the officers and directors of each local A.O.A. Post and the members of the national Technical Divisions and Sections. The Directory also includes the Honor Roll of the Company Members of the Association, and an organization chart of the national society. It is available to A.O.A. members only.

- The Index to Volume XLIII of ORDNANCE also is available. It is arranged alphabetically by subject and author with title page for binding and covers issues No. 229 (July-August 1958) to No. 234 (May-June 1959) inclusive.

- Address requests to:

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BOOKS RECEIVED

Asbestos: Its Industrial Applications. By D. V. Rosato. New York: Reinhold Publishing Corporation. 214 pp. $5.75.

Basics of Missile Guidance and Space Techniques. Two volumes. By Marvin Hobbs. New York: John F. Rider Publisher, Inc. 304 pp. $3.90 each, paperbound; $9.00 set, in cloth binding.

Battle for the Rhine. By R. W. Thompson. New York: Ballantine Books, Inc. 205 pp. 50 cents, paperbound.

Boeing 707. By Martin Caidin. New York: Ballantine Books, Inc. 210 pp. 50 cents, paperbound.

Concise Dictionary of Science. By Frank Gaynor. New York: Philosophical Library, Inc. 546 pp. $10.

Guide for Army National Guardsmen. By James B. Deerin. Harrisburg: Stackpole Company. 322 pp. $3.50.

High Altitude and Satellite Rockets. A symposium sponsored by the Royal Aeronautical Society, the British Interplanetary Society, and the College of Aeronautics at Cranfield, England, July 18 to 20, 1957. New York: Philosophical Library, Inc. 136 pp. $15.

Joint and Combined Staff Officer's Manual, The. By Col. J. D. Nicholas, U.S.A.F., Col. G. B. Pickett, U.S.A., and Capt. W. O. Sears, Jr., U.S.N. Harrisburg: Stackpole Company. 272 pp. $4.50.

Medical Science and Space Travel. By William A. Kinney. New York: Franklin Watts, Inc. 150 pp. $3.95.

New Drill Regulations. Harrisburg: Stackpole Company. 130 pp. $2.50.

Officer's Guide, The. 24th Edition. Harrisburg: Stackpole Company. 482 pp. $5.

Principles of Transistor Circuits. By S. W. Amos. New York: John F. Rider Publisher, Inc. 176 pp. $3.90.

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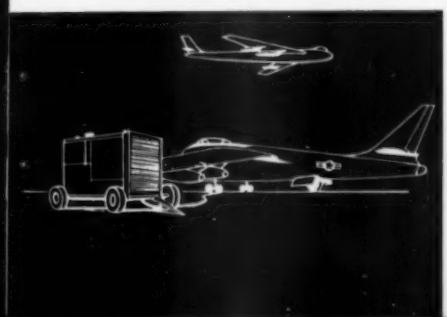

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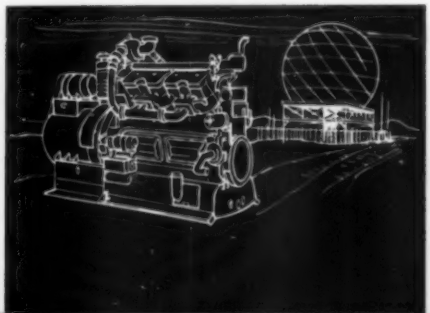
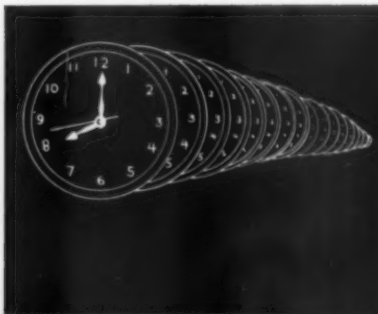
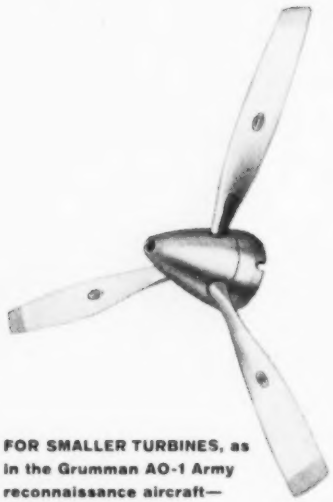


ENDURANCE. At Air Force Bases in the Atlantic, Cat Electric Sets have run over 20,000 hours without overhaul, while supplying 68,000 kwh a month.





FOR SMALLER TURBINES, as in the Grumman AO-1 Army reconnaissance aircraft—the 53C51 Hydromatic

FOR LARGER TURBINES, as in the Lockheed Electra airliner and the C-130B military transport—the 54H60 Hydromatic

Hamilton Standard's Hydromatic Propellers

CHOSEN FOR ADVANCED TURBOPROP AIRCRAFT

THE FINEST PROPELLERS designed specifically for turbine engines are these Hydromatics . . . incorporating Hamilton Standard's nonrotating integral oil supply and control, dependable, easily-maintained aluminum alloy blades, and proven Hydromatic design. They are the latest in the line of more than half-a-million Hamilton Standard propellers produced for the free world's military and commercial aircraft.

These new propellers are products resulting from twenty years of research and development in the turboprop field. They reflect a rich and unique heritage of skills and experience gained through 40 years of leadership in the ever changing world of flight.

HAMILTON STANDARD

Windsor Locks, Connecticut

ENGINE CONTROLS • ENVIRONMENTAL CONTROL SYSTEMS • PROPELLERS • STARTERS
FLIGHT CONTROLS • VALVES • PUMPS • GROUND SUPPORT EQUIPMENT

DOW | MAGNESIUM PRODUCTS

400-TON PRESS draws end pieces of magnesium transmitter housing for missile ground support electronic system. Heated dies make possible one step draws.

The electronic transmitter housing shown in various stages of production on this page is a good example of the type of work carried on at Dow's Bay City Fabrication plant. It is a large and complex assembly which is produced in quantity, involves many different operations, and must conform to extremely high quality standards.

Large or small jobs. The Bay City plant is a large, well equipped magnesium production facility set up to handle large or small jobs, and plenty of both. Its activities encompass every phase of fabrication — deep drawing, bending, spinning, stamping, piercing, machining, arc and spot welding, assembling, chemical treating and painting. The facilities are government certified.

Engineering and quality control. Dow engineers working closely with the customer are frequently able to suggest design modifications which cut costs and/or meet application requirements better. A quality control team using modern methods and equipment assures that high standards of craftsmanship are rigidly maintained.

Many "firsts". The Bay City Fabrication plant has pioneered many developments in the production of magnesium parts and products. They were first to hot draw the lightest structural metal, and first to spot weld and automatically weld it. They have also been a leader in the production use of chemical treatments and finishes for magnesium.

Whatever your requirements, if they involve magnesium fabricated parts or assemblies, it will pay you to make Dow your supplier.

ARE YOU UTILIZING DOW'S EXTENSIVE MAGNESIUM FABRICATION FACILITIES?

Dow, primary producer of magnesium and its alloys, offers capacity and outstanding capabilities of its Bay City Fabrication plant.

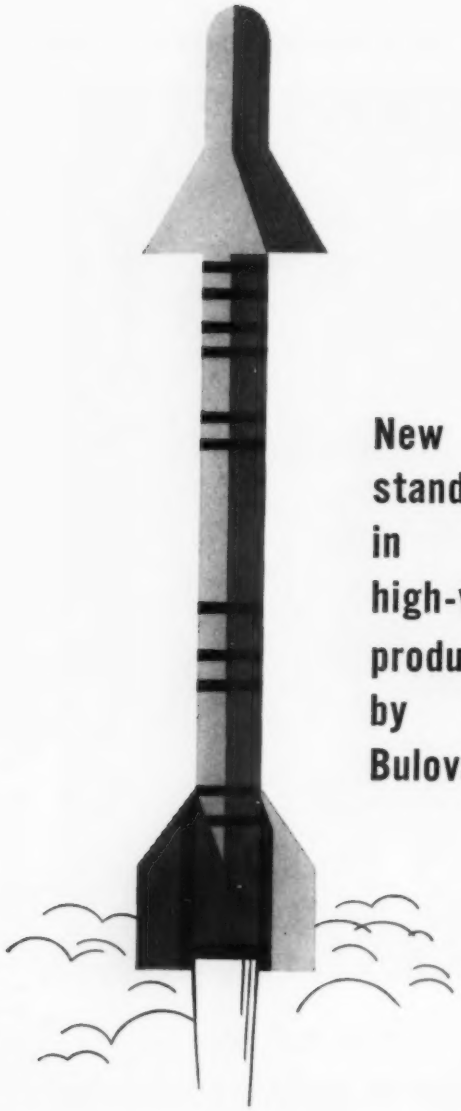
WRITE TODAY for this illustrated brochure discussing Dow fabrication services. THE DOW CHEMICAL COMPANY, Midland, Michigan, Magnesium Product Sales Department 1212DF9.

"WRAPPER", or shell of housing is roll formed of magnesium sheet.

AUTOMATIC ARC WELDER, using tungsten-inert gas process, joins end to wrapper.

ASSEMBLY involves attachment of doors, hardware, other components using riveting, bolting, welding.

THE DOW CHEMICAL COMPANY · MIDLAND, MICHIGAN



New standards in high-volume production... by Bulova

Bulova ingenuity permits minimum inspection.

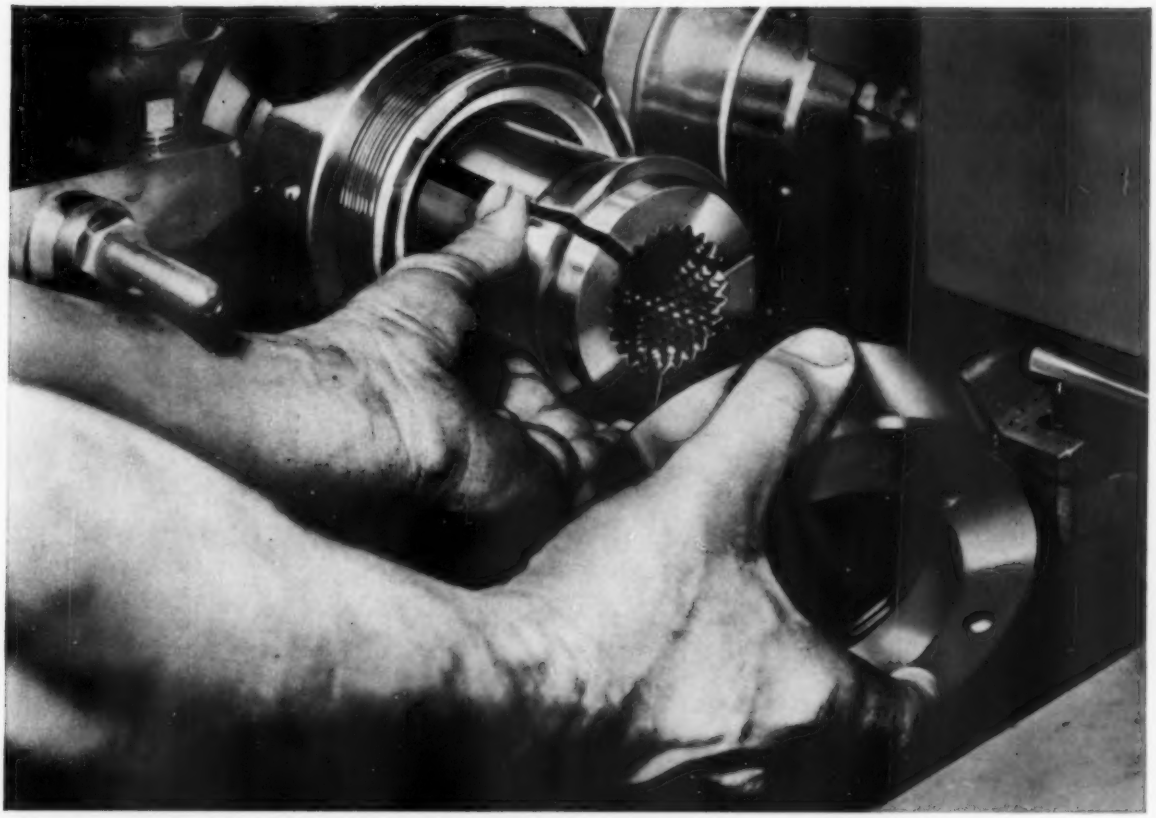
High-volume production techniques . . . perfected by Bulova to maintain their leading competitive position in consumer markets . . . assure repeatability and reliability of industrial and defense products.

To date, Bulova has manufactured more than 4,000,000 arming devices. Although reliability was crucial, only approved sampling techniques were required for inspection.

Experience in precision design and precision manufacture is the Bulova tradition, the Bulova capability. It has been for over 80 years. For more information write —

Industrial & Defense Sales, Bulova, 62-10 Woodside Ave., Woodside 77, N. Y.

BULOVA



Inspecting 4615 nickel alloy steel spindle in Greenlee 6-Spindle 2" Automatic Bar Machine assembled with collet and 4615 steel spindle nose nut. Greenlee Bros. & Co., Rockford, Ill., also produces 1" and 1⅝" bar machines.

How Greenlee uses two general purpose nickel alloy steels to keep precision machines precise

1...case-hardening 4615 for wearing parts 2...through-hardening 4340 for stressed parts

Do you know that by varying heat treatment of just two nickel alloy steels – 4615 for case-hardening, 4340 for through-hardening – you can give desired hardness and strength to most heavy-duty machine tool parts?

For proof – consider the Greenlee 2-inch automatic bar machine above.

Each spindle is 4615 steel, carburized and hardened to Rockwell C 62-64. The hard case holds down wear or loss of running accuracy, even though spindles turn directly on 5 speed ball bearings. High speed torsional stresses are taken in stride by the tough, strong core. The low distortion characteristics of 4615 steel during heat treatment help to keep true-running accuracy.

4615 steel also gives the same excellent wearing qualities in spindle nose nuts, idler gears, bushings and sleeves.

4340 steel strengthens highly stressed parts

Through-hardening 4340 nickel alloy steel is the off-the-shelf steel Greenlee uses for heavily stressed parts – for example, certain shafts heat treated up to 225,000 psi tensile strength.

Stocked in Steel Service Centers across the country

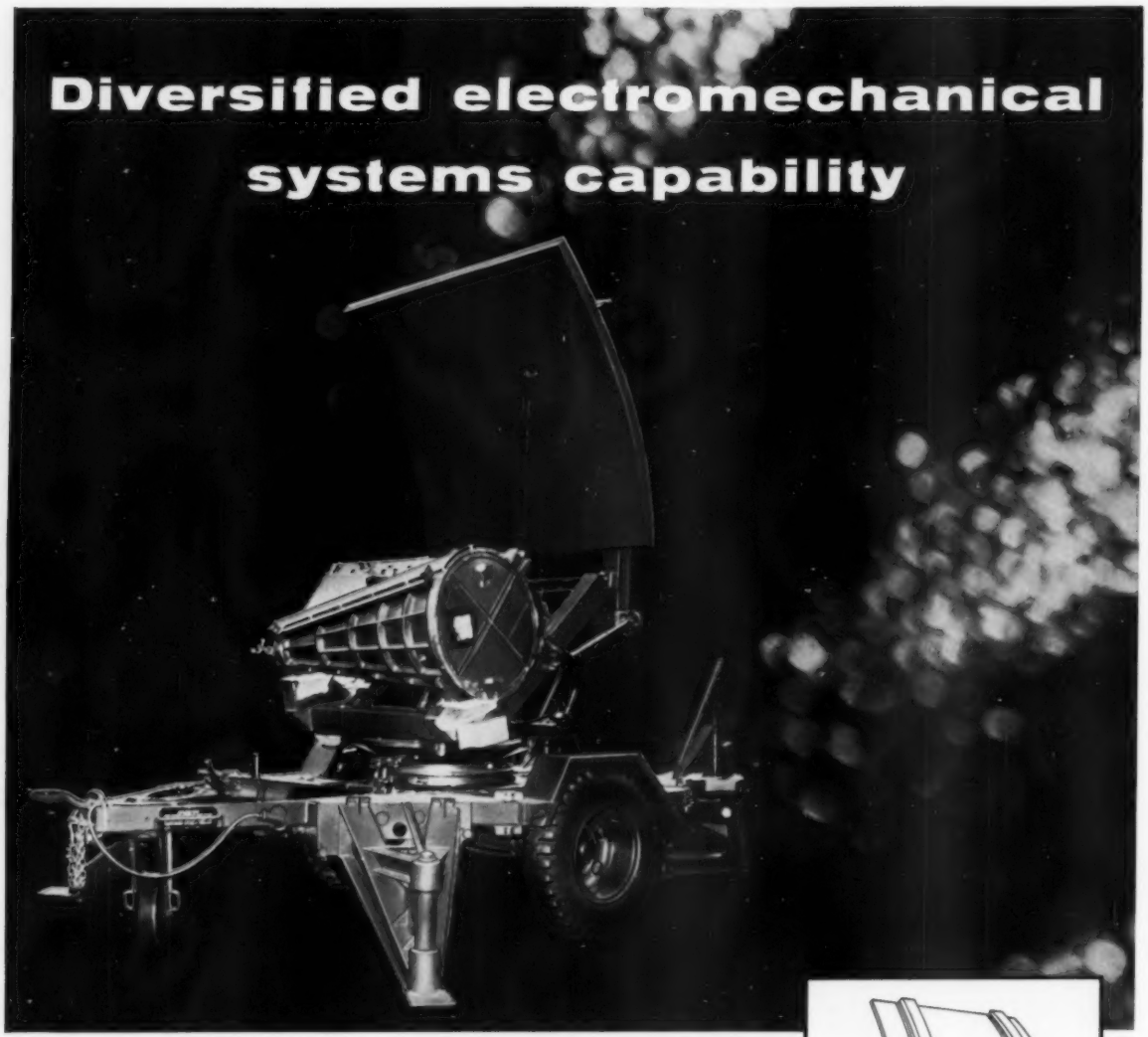
Versatile 4615 and 4340 nickel alloy steels are available for quick delivery from Steel Service Centers throughout the country . . . ask us for a list of centers where you can buy them. Write us, too, for specific questions concerning these two steels.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N.Y.

INCO NICKEL

NICKEL MAKES ALLOYS PERFORM BETTER LONGER

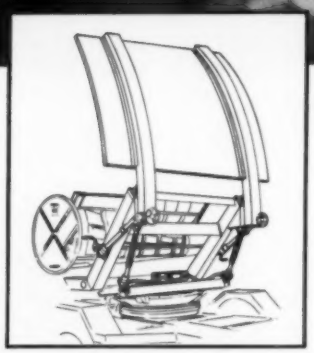
Diversified electromechanical systems capability



AiResearch Actuation Systems For Portable Radar represent a typical electromechanical systems application in ground support equipment. Two types of AiResearch actuation systems are now in production for the Army's mobile trailer-mounted ground radar unit. They consist of a manually operated antenna folding storage system and an electrically powered antenna elevation system.

Designed to operate under the most severe environmental conditions, this type of electromechanical system can operate on 60 cycle A.C., 400 cycle A.C., or 28 volt D.C. Other suggested applications include: *missile launchers, missile ground handling and support equipment, armored vehicle fire control and ballistic handling systems, and mobile communications equipment requiring servoed actuating systems.*

AiResearch leadership in the development and production of electromechanical equipment for aircraft, ground handling, ordnance and missile systems of all types also includes such recent examples as spoiler servo control systems, magnetron and Klystron tuning devices, and safe-arm mechanisms for missile igniting. We invite you to submit a problem statement of your electromechanical requirements.



U.S. Army Signal Corps ground portable radar unit operated with two AiResearch electromechanical actuation systems.

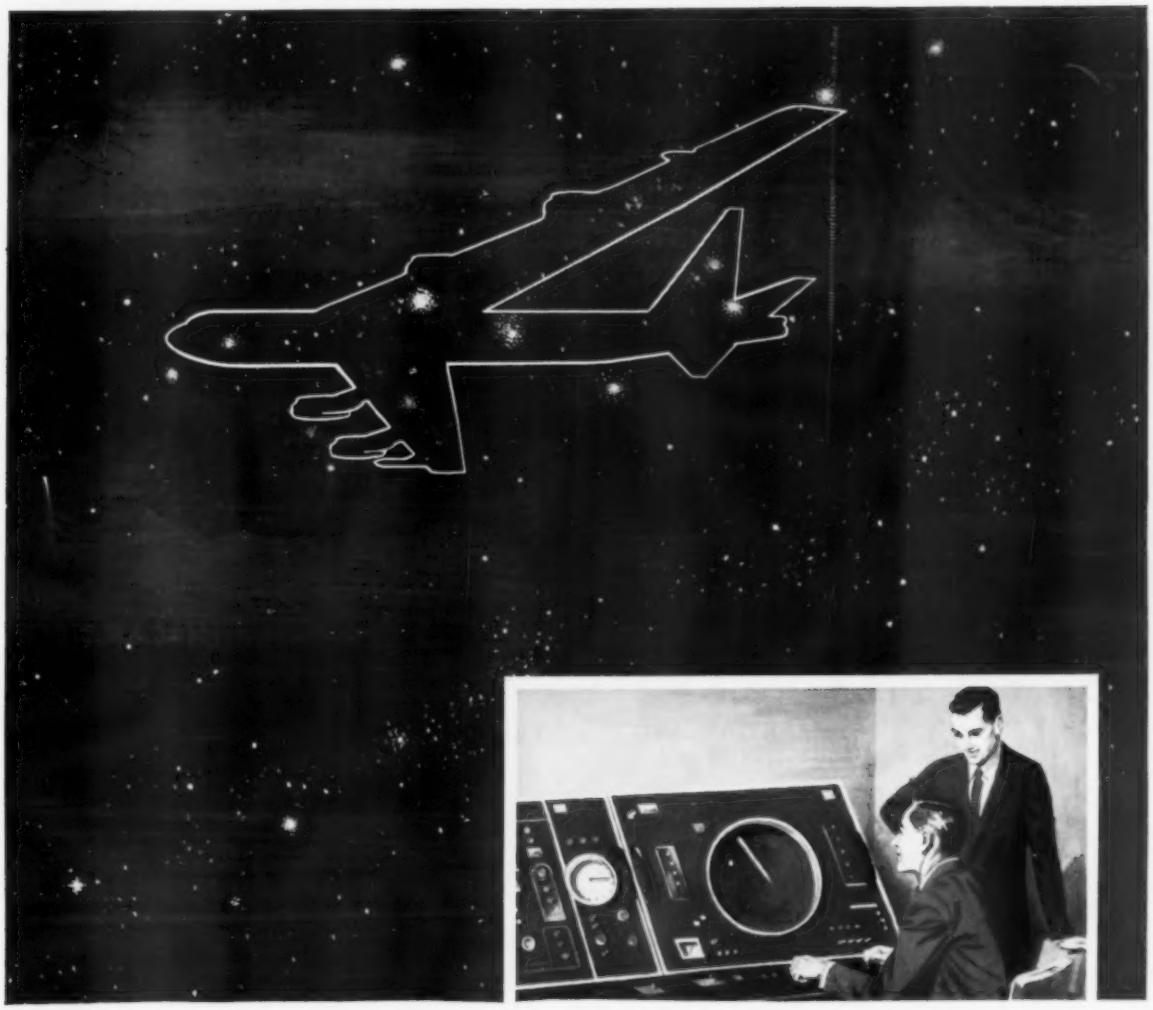
THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

SYLVANIA ELECTRONIC SYSTEMS . . . **IN SIMULATION**



Creating electronic "realities" in a low-cost manageable package

SIMULATING CONDITIONS of actual operations for flight trainers, radar operators, or space travelers is an experienced and growing facility of Sylvania Electronic Systems.

Good examples are Sylvania's participation in the Navy's Universal Digital Operational Flight Trainer and "ACTER," a new Sylvania development which will add ECM conditions to existing radar training gear.

Undoubtedly the simulation of space travel can be enhanced materially by current simulation projects.

In simulators or trainers, as in every major area of electronic systems, Sylvania can assume full responsibility from system analysis and management through research and engineering, product design, production to field engineering.

Sylvania welcomes the opportunity to outline its special talents and capabilities to you or your organization personally. *Simply address your inquiry to division headquarters, address below.*

Sylvania Electronic Systems
A Division of Sylvania Electric Products Inc.
63 Second Avenue, Waltham, Mass.

SYLVANIA
Subsidiary of
GENERAL TELEPHONE & ELECTRONICS

RECORD TELEVISION PICTURES ON TAPE

AMPEX VIDEOTAPE* TELEVISION RECORDER

The simplicity of tape recording is brought to closed circuit television applications with the Ampex VR-1000B. Picture and sound, or 4,000,000+ cycle data are recorded with advantages not available with film or other data-recording media.

IMMEDIACY The picture being recorded – either from a direct or beamed signal from the television camera – can be monitored as it is recorded. Moments later, when rewound, the tape can be replayed on the TV monitors.

SECURITY You record, duplicate and play back your recording, independent of any outside service. And the recordings can be sent at your discretion to any other Ampex equipped facility for playback.

SAFETY The Recorder can be placed in a safe, remote location, completely removed from the television camera. The success of the recording is not conditioned by the safe return of the camera.

LIVE QUALITY The complete grey scale is captured. Video playbacks look "live". There are two separate audio channels simultaneously recorded on the same tape for auxiliary data or sound.

SIMPLICITY 96 minutes of both picture and sound can be recorded on a reel of 2-inch wide magnetic tape.

ECONOMY Full color recording can be made on the same tape used for black and white, requiring only the addition of a single electronics rack. **Tape recording is less expensive than any other recording media.**

ULTRA-HIGH RESPONSE
DATA RECORDER The Ampex Videotape Television Recorder is not limited to television recording. It will record electronic signals ranging from 0 to more than 4,000,000 cycles/per/sec. storing up to a million bits of information in less than 4 inches of tape, 2 inches wide.

Graduate engineers, thoroughly versed in government and military applications and procedures are available at Ampex to answer your questions. Address inquiries to Department 304-1. A booklet "Advanced Applications" and a technically complete brochure "VR-1000B" are yours for the asking.

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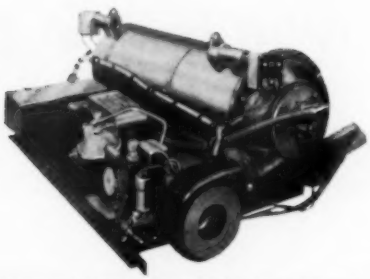
Offices and Representatives in Principal Cities Throughout the World

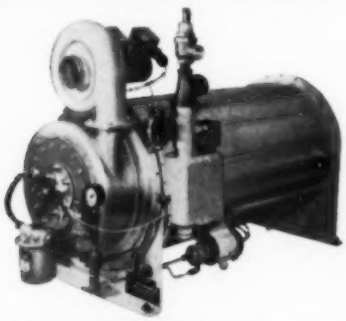
VIDEOTAPE™ AMPEX CORPORATION *professional products division*

*TM AMPEX CORP.



90,000 Btu/hr Janitrol liquid heater

for support vehicle comfort and cargo heating, windshield defrosting. Ideal for use on fire trucks, movers, weapons loaders, personnel carriers, in temperatures to −65° F.



500,000 Btu/hr Janitrol liquid heater

for portable structures, large vehicles, and for heating decontaminents and cleaning fluids on mobile ice removal units.

1,000,000 Btu/hr Janitrol liquid heater

for missile fuel transfer operations, large portable structures, airlifted equipment. Approximately 18″ in diameter, 47″ high, weight: 260 lbs.

reliable ground support liquid heat packages

Missile and aircraft support equipment builders use Janitrol *liquid* heater packages with little or no modification because they're designed for military applications. Meeting appropriate MIL specifications and fully qualified, they're available in outputs to 1 million Btu/hr. They provide any desired amount of heat up to rated output and automatically maintain constant temperatures.

As an example of acceptance, most Air Force crash-fire vehicles are equipped with one or more of these heaters, for engine, chemicals, cargo and crew space heating. Multi-fuel operation is standard, and they perform reliably in multiples for heat requirements which exceed the output of a single unit.

Ask your Janitrol engineering representative for a proposal for thoroughly proven ground support heating equipment.

Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 4, Ohio.

JANITROL

pneumatic controls • duct couplings & supports • heat exchangers
combustion equipment for aircraft, missiles, ground support

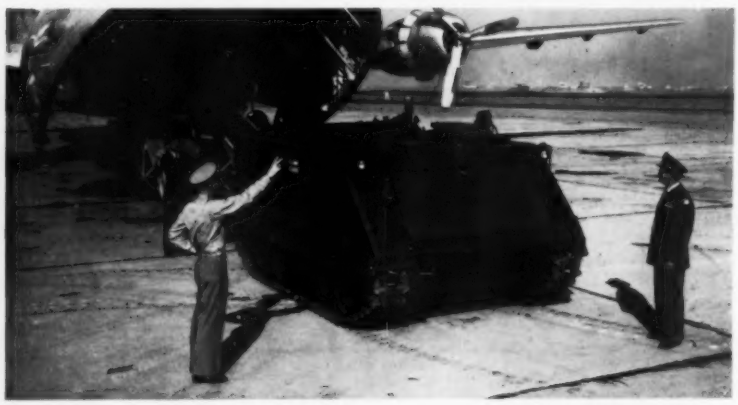
New Kaiser Aluminum Weldable Alloys

Aluminum alloys 5083 and 5086 have been developed by Kaiser Aluminum for welded structures requiring maximum joint strength and efficiency, particularly those subject to impact or dynamic loading.

Kaiser Aluminum alloys 5083 and 5086 are high strength, non-heat-treatable, weldable alloys offering seven distinct advantages:

1. **GREATER DESIGN EFFICIENCY FOR WELDED STRUCTURES.**
2. **SUPERIOR WELDING CHARACTERISTICS.**
3. **EXCELLENT FORMING PROPERTIES.**
4. **HIGH RESISTANCE TO CORROSION.**
5. **ECONOMY EQUAL TO OTHER NON-HEAT-TREATABLE ALLOYS.**
6. **IMPROVED WELD ZONE DUCTILITY.**
7. **HIGH STRENGTH IN THE AS-WELDED CONDITION.**

These weldable alloys are designed with improved properties for products subject to impact or dynamic loading. They have proved, through extended testing and on-the-job use by many industries, complete reliability under every requirement imposed upon them.



A new amphibious, air transportable and air-droppable aluminum armored personnel carrier, the M113, built by Food Machinery & Chemical Corporation's Ordnance Division, San Jose, California, is shown being loaded aboard an Air Force C-124. The M113 was engineered and developed under the direction of Ordnance Tank-Automotive Command U. S. Army to replace the steel model M59. The hull of the vehicle is primarily made of Kaiser Aluminum alloy 5083 plate, extrusions and forgings.

FASTER WELDS POSSIBLE

An outstanding characteristic of these high magnesium-aluminum alloys is their ability to take full advantage of inert-gas, shielded-arc welding methods. Fast, superior welds and pressure tight joints are thus assured. These are the strongest A.S.M.E. approved aluminum alloys available for the fabrication of unfired pressure vessels without thermo stress-relieving.

Many military products are now being made better at less cost with Kaiser Aluminum alloys 5083 and 5086. The M-113 track vehicle illustrated in Figure 1 is one example. Others include such products as missile structures and skins, missile containers, cryogenic tanks, radar antenna, destroyer gun mounts, crew boat hulls, bridges, overhead cranes, flatbed trailers and armored and amphibious vehicles.

Available in sheet, plate, forgings and extrusions in annealed and rolled tempers, alloys 5083 and 5086 make possible hundreds of new uses for aluminum in military applications. If you want further information, we'll be glad to assist you. Our staff of specialists in metallurgical research, product engineering and field engineering is at your disposal. Call or write:

Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

FREE! A Complete Portfolio On Aluminum In The Defense Industry

For your information and reference, Kaiser Aluminum offers the complete results of its comprehensive survey of the uses of aluminum in the missile industry—plus data on alloys 5083 and 5086 as used in cryogenics and other military applications. For your free portfolio, write for "Aluminum In The Defense Industry": Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California.

TYPICAL MECHANICAL PROPERTIES OF ALUMINUM ALLOYS 5083 AND 5086 COMPARED TO ALUMINUM ALLOY 6061 AND MILD STEEL

	5083		5086				6061				Mild Steel
	"O"	"H113"	"O"	"H32"	"H34"	"H112"	"O"	"T4"	"T6"	As Welded	ASTM A201B
Tensile Strength (psi)	42,000	46,000	38,000	42,000	47,000	39,000	18,000	35,000	45,000		60,000 Min.
Yield Strength (psi)	21,000	33,000	17,000	30,000	37,000	19,000	8,000	21,000	40,000		32,000 Min.
Elongation (% in 2")	22	16	22	12	10	14	30	25	17		25
Fatigue Strength, psi		23,000			15,000	22,000	9,000	14,000	14,000		34,000
Ultimate Shearing Strength	25,000		23,000		27,000		12,000	24,000	30,000		42,000
Mod. of Elasticity, psi	10.3×10^6		10.3×10^6				10.0×10^6				30.0×10^6
Estimated Welded Joint Efficiency		91%				91%	100%		96%	67%	100%
Typical Prop. of Sound Welds (Machined Flush)									**Reheat Treated to T6**		
Tensile Strength (psi)		43,500				39,000			43,000	29,000	66,000
Yield Strength (psi)		22,000				17,000			30,500	17,000	55,000
Elongation (% in 2")		16				21			5	5–13	25%
Filler Alloy		5183				5356			5356	5356	E6020

TYPICAL PHYSICAL PROPERTIES

	5086	5083	6061	Mild Steel
Density (lb./cu. in.)	.096	.096	.098	.284
Specific Gravity	2.66	2.66	2.70	7.88
Thermal Conductivity at 25°C (CGS units)	.30	.28	.39	.12
Average Coefficient of Thermal Expansion 68°F to 212°F (approx.)	13.2×10^{-6}	13.2×10^{-6}	13.1×10^{-6}	7.2×10^{-6}
Melting Range (approx.)	1084–1184°F	1065–1180°F	1080–1200°F	2600–2800°F

NOMINAL CHEMICAL COMPOSITION

5086:	Magnesium, 4.0%;	Manganese, 0.45%;	Chromium, 0.10%	
5083:	Magnesium, 4.45%;	Manganese, 0.75%;	Chromium, 0.10%	
6061:	Magnesium, 1.0%;	Copper, 0.25%;	Silicon, 0.60%;	Chromium, 0.25%
A201B:	Carbon, 0.20%;	Manganese, 0.60%;	Phosphorous, 0.02%;	Sulfur, 0.02%; Silicon, 0.23%

KAISER ALUMINUM

THE BRIGHT STAR OF METALS

Just a wavelength from ANYWHERE . . . via AIRCOM
Why Philco has been selected to modernize the world's largest communications system
AIRCOM is the vast, global network of electronic communications that links every base, outpost and aircraft of the U. S. Air Force. It is the world's most extensive integrated communications system.
Recently awarded the contract to modernize and expand AIRCOM, Philco was selected by the Air Force for its proven ability in systems management and its extensive experience in global communications.
The modernized AIRCOM System will utilize advanced techniques in both point-to-point and air-to-ground communications. It will provide greater traffic capacity, maximum reliability and complete compatibility of all USAF communications equipment.
In the world of advanced electronics . . . in communications, data processing, missiles, satellites, weapons systems and radar . . . look ahead and you'll choose Philco.
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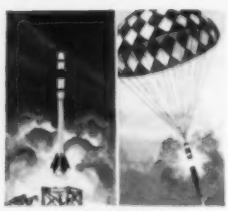


POGO-HI
(II E3c)

P-107
AIR LAUNCHED

P-106
GROUND LAUNCHED

AERONCA TARGET MISSILES PERFORM A VARIETY OF MISSION PROFILES... WITH SUBSTANTIAL ECONOMY

The adage "practice makes perfect" keynotes today's concept of missile warfare. Against supersonic targets, there isn't time for "the second barrel". Therefore, extensive operational testing of air defence systems . . . and training programs for personnel who operate them . . . must be conducted to assure national preparedness.

To accomplish this requirement at minimum cost, Aeronca has developed two expendable, lightweight, high-performance target systems under the Design-Tool-Produce envelope concept. These proprietary missile programs, the P-106 and P-107, are designed for supersonic performance and accurate scoring at all required altitudes, speeds and ranges. ***And their production cost is projected to be substantially less than any current target missile system!***

Another Aeronca-produced missile project is *Pogo-Hi II E3c*. Ground launched to high altitudes, this target utilizes a radar reflective parachute and an infrared emitter package. It is used as "bait" for such current projects as *Nike, Talos, Sidewinder* and *Falcon*.

With integrated Design, Tooling and Production capabilities, Aeronca can produce weapon systems envelopes at either prime or subcontractor levels.

AERONCA manufacturing corporation
1718 GERMANTOWN ROAD • MIDDLETOWN, OHIO

Operational expansion has created openings for additional senior engineers. Write to W. W. Gordinier, Personnel Manager.

Products	Types and Salient Features	Ratings
SYSTEMS Single Source Responsibility · Coordinated Component Design		
a-c and d-c electric power systems	brushless generators, static exciters, control panels and regulators.	a-c up to 160 kva. d-c up to 750 amps.
variable-speed constant-frequency systems	(same as above)	VSCF up to 120 kva.
actuator systems	linear and rotary—electric, hydraulic, pneumatic and mechanical. Feedback control features. Integrated sensing and control devices.	to spec.
COMPONENTS		
actuators and geared drives	electric, hydraulic, pneumatic and mechanical. Lightweight, high temperature.	to spec.
a-c and d-c motors	"flexible standard" building block design permits completely customized motor for rapid delivery. Also SECSYN* brushless design for a-c requirements.	up to 20 hp in SAE Frames IV, V and VI. Also special configuration and ratings to specs.
engine starters	lightweight, high performance	up to 30 hp.
starter-generators	a-c and d-c. Compact, lightweight, high efficiency. Self-cooled and blast-cooled.	up to 750 amps d-c for engines rated to 4000-lb thrust or equivalent hp.
solenoids	a-c and d-c. High temperature.	to spec.
a-c tach and synchronizing generators	lightweight. Ambients to 750F.	to spec.
inverters	rotating and static designs. Static—transistor or controlled rectifier. Rotary—with static controls.	up to 3000 va.
relay networks	a-c and d-c for voltage, frequency, current and fault sensing.	to spec.
transformers, current	special low-power sensing and std. high-power sensing units. Lightweight L-P sensor ideal for differential protection, real load division and unbalanced current relaying.	to spec.
circuit breakers	a-c. Phase barriers throughout; balanced rotary latch; direct solenoid-actuated contacts; non-critical adjustment of interlocks.	to spec.
transformers, power	single and three-phase. High temperature.	to spec.
control panels	a-c and d-c. Customed to provide all protective and control functions specified. Printed circuits, static components and encapsulation.	matched to system requirements.
regulators and static exciters	transistor, controlled rectifier, mag-amp or carbon-pile. Average or Hi-Phase® sensing.	matched to system requirements.
generators, a-c	all contemporary generator types plus SECSYN* brushless and variable-speed constant-frequency (VSCF) design.	up to 160 kva. VSCF to 120 kva.
generators, d-c	all contemporary generator types plus SECSYN* brushless. High temperature and high speed.	up to 750 amps.

*Stationary-Exciter-Coil SYNchronous machines. Brushless, lightweight, extremely reliable design used as generator or motor.

Today's answer to your problem lies within these more than 400 proved J&H designs

J & H offers the most complete range of electric power systems and components available from a single source. Hardware developed, produced and placed into service over the past twenty years represents the conventional and the most sophisticated . . . and application is across the spectrum of aeronautics and astronautics:

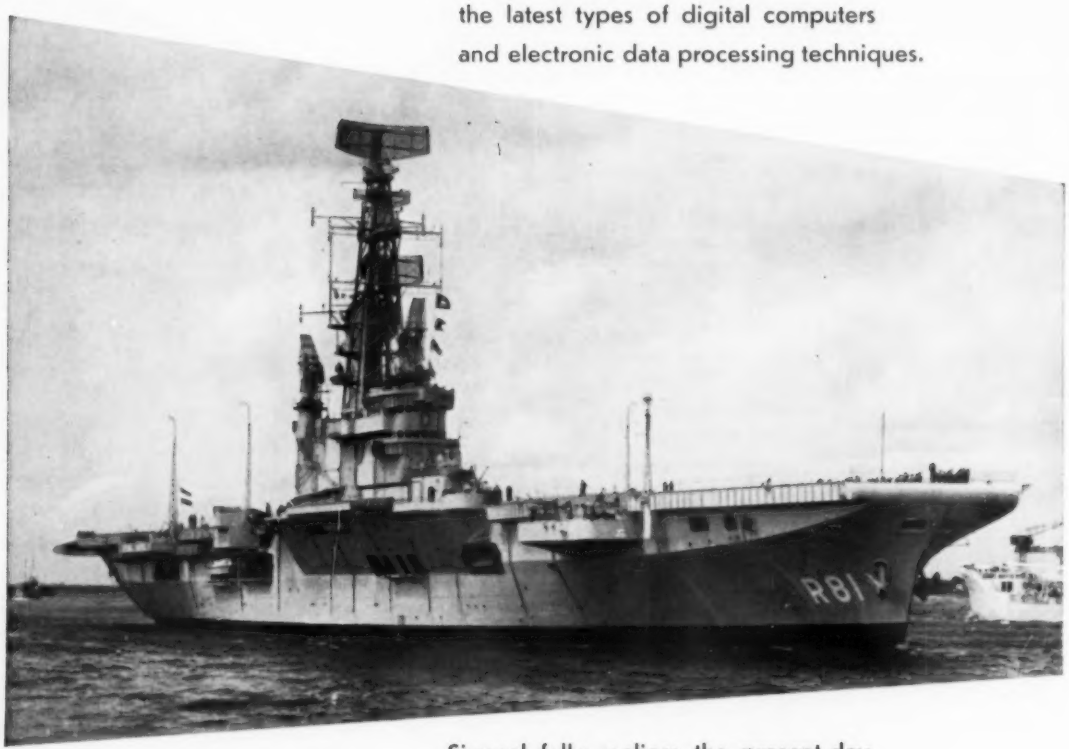
1 missiles of all classifications
2 missile ground support systems
3 manned military aircraft of all types
4 aircraft GPUs and APUs
5 commercial aircraft
6 personal and utility aircraft

JACK & HEINTZ, Inc.
SYSTEMS FOR AIRCRAFT, MISSILES, GROUND SUPPORT

For detailed information on the systems and components outlined at the left, write to Jack & Heintz, Inc., 17633 Broadway, Cleveland 1, Ohio.

SIGNAAL

SIGNAAL produces a wide variety of complex electronic and mechanical equipment. The emphasis throughout is on the design of complete systems rather than on disconnected units. The principal products of the company are automatic weapon control systems, radar systems, and the automatic air traffic control system SATCO, using the latest types of digital computers and electronic data processing techniques.



Signaal fully realizes the present-day need for complete integration of warning and fire control equipment to make the best use of all available weapons. The company is now able to offer automatic and integrated naval weapon control systems providing long range warning, aircraft control, target indication, and fire control against air, surface and underwater targets.

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Write for Bulletin No. 132

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ORDNANCE DAY

OCTOBER 8, 1959

The Forty-first Annual Meeting of the American Ordnance Association will be held at Aberdeen Proving Ground, Md., on Thursday, October 8th. Guided missiles, rockets, tanks, guns, fire control, and other modern armament and equipment will be displayed and tested for A.O.A. members.

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I—134

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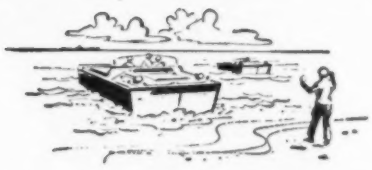

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Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

Time-Lapse Photography

An efficient means for recording prolonged scientific experiments

William A. Bowles

Assistant Chief, Photo Branch, Lewis Research Center, NASA, Cleveland, Ohio

RAPID and widespread dissemination of scientific data is getting a strong boost at the National Aeronautics and Space Administration through the extensive use of time-lapse photography.

The NASA, at its Lewis Research Center, Cleveland, Ohio, is engaged in studies of aircraft, missile, and spacecraft power-plant problems. With more than $125 million worth of research facilities available and in use at the center, the number of man-hours spent by scientists and technicians in turning out reports needs to be kept at a minimum.

SINCE NASA is charged with directing all Government aeronautical and space activities—except those primarily military in nature—its findings are of prime importance to the military and to the aeronautics industry. Also, the rapid advancement of the United States space program is dependent on widespread availability of any and all scientific findings.

NASA personnel have found that time spent in producing comprehensive reports can be cut significantly—from ten to fifty per cent in many instances—by compressing experimental studies through the use of time-lapse photography. As one researcher explained it, the film produced has the effect of multiplying attendance at the original experiment as much as a thousandfold. He explained further that time-lapse films make it possible to demonstrate an experiment over and over in a fraction of the time required for the original study. In addition, key equipment is left free for new and more advanced studies.

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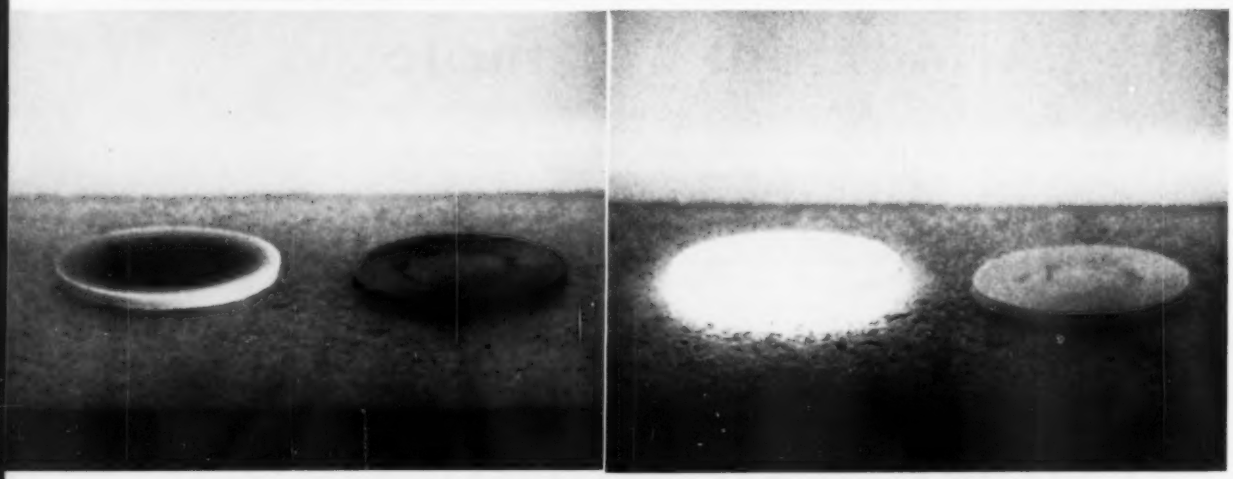
UTILIZATION of time-lapse photography is particularly in evidence at Lewis' Materials and Stresses Laboratory. Here researchers are concerned primarily with studies leading to the development of practical nuclear propulsion systems for aircraft and spacecraft. Considerable research also is being conducted on high-temperature metals and ceramics. Particular interest centers around creep, fatigue, and physics of solids.

These latter studies also should have considerable applicability in future designs of supersonic ballistic missiles, rockets, and other weapons.

Many of the tests and studies conducted by the Materials and Stresses people require observation covering many hours, and, at times, several days. Using time-lapse photography, researchers are able to condense these experiments into filmed presentations requiring only minutes to show—thus capsulizing significant developments.

One such test conducted recently was designed to show the oxidation proper-



Figs. 1 and 2: Time-lapse photos taken during 3-hour test of metals in a furnace at 1,500 degrees F.

ties of columbium, a heat-resistant metal. One of the specimens was pure columbium while the other was an alloy containing 5 per cent chromium. The two specimens were placed in a furnace and held at 1,500 degrees Fahrenheit for a 3-hour period.

During the entire test, a camera was recording the visual effects of oxidation on color film. However, rather than run three hours of film, the special camera involved was set to expose one frame every fifteen seconds.

The camera was positioned outside the furnace—but equipped with a telescopic lens. This yielded a close-up view of the high-temperature proceedings which would have been impossible with the naked eye. Further, the color film was able to pick up and record subtle color changes that might have escaped the personal observation of a researcher in the high-temperature situation which tends to distort color values.

RESULTS of the experiment dramatically illustrated that the rate of oxidation for the columbium-chromium alloy was reduced by a factor of ten times as compared with the pure columbium. Evidence of the findings is available on film which shows the pure columbium oxidizing into a grotesque mass. This can be seen in one minute of projection time as a result of using time-lapse photography.

In addition, data obtained in the experiment—plus a visual presentation—are readily available for reference at Lewis or any other agency or industry involved in developing materials that must withstand the high temperatures encountered in high-speed travel.

IN another section, researchers are involved in investigating the boundary-layer properties of airframe and missile configurations. These tests are conducted in a wind tunnel that will give speeds up to and including Mach 3.5. One particular test consisted of spraying a red-painted airplane model with white china clay. The model was then coated with a volatile oil, making the white china clay transparent and allowing the red paint to show through.

Before starting the actual test, a time-lapse photographic setup was installed to record the events on color film at a rate of one frame a second.

The object of the test was to provide qualitative answers to the relationship of design configuration to friction-generated heat in laminar and turbulent boundary layers. Results of these continuing tests are valuable both in the design of spacecraft and supersonic aircraft and also in the design of future high-speed ballistic missiles and projectiles.

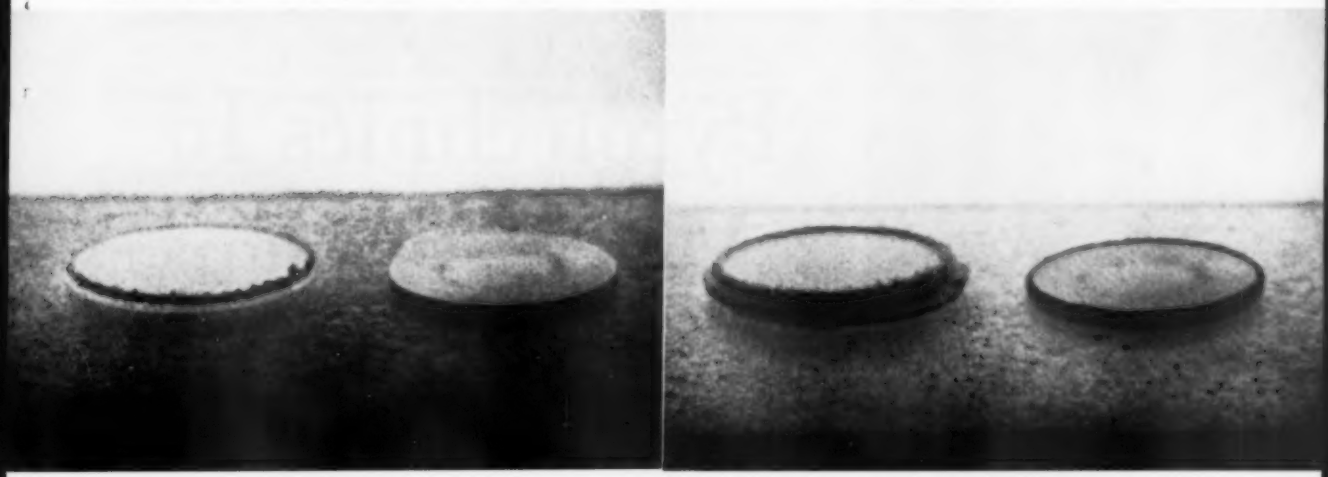
In the course of the wind-tunnel test, the model—of standard delta-wing configuration—was subjected to continuously greater speeds. The effects of boundary layers became evident as the volatile oil began to evaporate along leading and trailing edges of the wing—areas most commonly affected, respectively, by laminar and turbulent boundary layers.

In such a test, the observance of minute color changes is of prime importance in deriving qualitative conclusions. Often it is necessary to observe such an experiment several times to identify and record these minute changes. By using time-lapse photography, the boundary-layer researchers were able to record the whole sequence on twenty minutes of color film. To have repeated the actual test, which required a number of hours for completion, many valuable man-hours would have been lost. In addition, repetitious work would have tied up the equipment.

WITH an eye toward the development of more advanced atomic reactors, the Lewis researchers are conducting experiments on the creep properties of materials subjected to prolonged periods of use at temperatures ranging from 4,000 to 5,000 degrees Fahrenheit. Again, the results of such experiments will be valuable in constructing future ordnance weapons—weapons that will have to withstand the ultrahigh temperatures resulting from friction created at supersonic speeds.

A test rig has been set up in the refractory metals section of Lewis' Materials and Structures Division for conducting tests in this field. Since many of the experiments will be run for twenty hours, the researchers have included a specially designed time-lapse camera jig as part of the over-all setup.

The material to be tested for creep



Figs. 3 and 4: Continuation of same test. In each shot, left sample is pure columbium; right, same plus 5% chromium.

properties is mounted inside a relatively small high-temperature furnace. Two wires are affixed to each specimen, approximately one inch apart. At the end of the experiment, the distance between these two wires can be measured—at known time intervals—directly on the film or on projected blow-ups.

After mounting the specimen, the furnace door is secured along with the camera jig. In addition to holding the camera, the jig carries a clock and a prism. Approximately two-thirds of the camera image area covers a small observation hole in the furnace door. The other one-third of the lens shoots into the prism and picks up the clock image on 70-mm. black-and-white film.

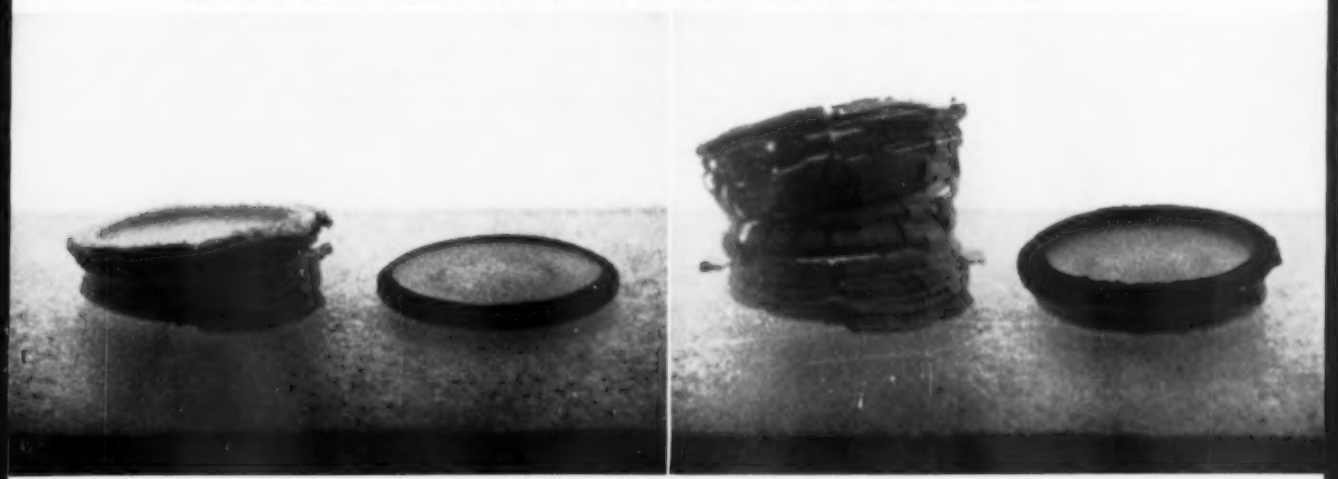
At the start of the test, the camera, which is capable of 340 exposures without reloading, is set to take one frame every 2 to 3 minutes. As the test progresses, the time differential of the photography is increased to one frame every 15 minutes.

ALTERNATIVE to time-lapse photography in this creep test might be an instrument such as a cathetometer (traveling microscope), but this would require a trained observer to be in constant attendance for periods up to twenty hours. However, time-lapse photography not only provides a record for dissemination but, equally as important, provides researchers with valuable information that would be obtainable only by prolonged personal monitoring via visual instrumentation.

These three experiments are indicative of how NASA is using time-lapse photography to provide a simple, accurate, and fast method of disseminating scientific information. Further advantages, as mentioned by NASA personnel, include the ability of a time-lapse camera to monitor an experiment, thus freeing a researcher for other important work.

The film-documented results are always readily available for repeat performances, thereby keeping expensive equipment free for new research. Finally, the time-lapse camera can observe and record in situations where a human being cannot.

Figs. 5 and 6: Effects of oxidation at high temperatures appear destructive much sooner on pure columbium at left.



Pyrotechnics In Missile Design

Reliable quality control assures effective use

Leonard Katz

Senior research engineer, Rocketdyne, Division of North American Aviation, Inc., Los Angeles, Calif.

THE advent of the missile era has placed tremendous demands on the development engineer for higher reliability and simultaneous reduction in component weight and size. Energy-producing or energy-transmitting units are called upon for greater and more reproducible output within the mandatory weight reduction. The units include the entire field of actuators, relays, delays, amplifiers, valves, and similar mechanisms.

For many of these units, pyrotechnics are the natural answer. Pyrotechnics and their higher-potency complements, explosives, will provide neat, compact, lightweight, highly concentrated energy units. These items in suitably designed mechanisms, can be used as ignition or separation devices, as delay units, relays, gas generators, valve operators, as actuating devices for linkages, as arming and fuzing devices, signal and tracking units, initiators of safety devices, cable cutters, and other allied uses.

Though the history of pyrotechnics and explosives is a long one, the paucity of the literature and the commercial secrecy which has for centuries cloaked the artificer of pyrotechnics has engendered suspicion and distrust among mechanical designers. In addition to this historical skepticism, there is the abhorrence that designers have regarding items which cannot be "tested" prior to use. They prefer to risk sticky solenoids, reluctant relays, delinquent delays, and adverse actuators because those units can be "tested."

Although these same designers are completely sold on statistical quality control, they believe that the rules of statistics are suspended for items that are instantly consumed in use. They disregard the fact that the earliest and most fruitful statistical quality control work was done at Frankford Arsenal (in collaboration with Bell Telephone Laboratories) and that the work was so successful that a malfunctioning round from an accepted lot of ammunition is now an extreme rarity. A round of ammunition is simply a combination of pyrotechnic devices.

Some of the critics are willing to agree that on large production lots it is perfectly possible to obtain quality-controlled pyrotechnic units of high reliability suitable for missile use, but they feel at this stage of missile development, where the quantities are small and the designs unique, that reliability cannot be attained. However, if the pyrotechnic selection and design are properly made, high reliability will be assured.

Proper selection and design in this context connote utilization of the services, talents, and products of the Government and Government-sponsored

Left. the Army's Redstone missile a few seconds after take-off.

agencies that specialize in pyrotechnic and explosives research. There are very few, if any, private companies whose individual work exceeds in sophistication and consummation that of the special agencies.

The list of these agencies is long and includes Picatinny Arsenal, the Naval Ordnance Laboratory, Frankford Arsenal, Franklin Institute, the Jet Propulsion Laboratory, and the Solid Propellant Information Agency.

The judicious blending of design and the utilization of the services and information of the special agencies can produce small-quantity lots of predictable high reliability and advanced pyrotechnic design.

The latest techniques, processes, mixes, and operating behaviors are available for study by the design engineer. The designer can usually, within the requirements that he must meet, select tested and approved highly reliable "stock" items and simply assemble and adapt them to his needs.

For a hypothetical design problem, let us assume that there is a requirement for an electrically initiated, 10-second-delay cartridge to operate a separation device. The requirements include operation at temperature extremes, under high acceleration and vibration forces and at extreme altitudes.

The selection of the electrically initiated squib can be made from the published lists of tested and approved squibs (*i.e.*, Franklin Institute lists). All the squib characteristics, electrical, pyrotechnic, environmental, etc., are listed, ensuring that the squib choice will be successful. The selected squibs can then be obtained from large, quality-controlled, inspected, and service-tested lots.

The delay mix can be selected from those developed and tested by Picatinny Arsenal and by the Naval Ordnance Laboratory. The burning rates, loading and storage characteristics, and environmental behavior of these delay mixes have been charted on the basis of thousands of tests.

If the geometry of the required design permits, delay units loaded by these agencies, or by manufacturers operating under processes, inspection, and test methods directed by the agencies, can be obtained and adapted. If adaptation is not possible, the processing of the mix and the loading thereof can be accomplished successfully by following the recommended specifications prepared by the agencies.

The selection of the powder charge can be made in similar fashion and will be indicated mainly by the task it is to perform. For a separation device it is likely that Frankford Arsenal's Cartridge Actuated Devices Handbook or the Solid Propellant Information Agency handbook will include the required propellant. If the propellant with the desired characteristics is not found in those books, there are also the large families of artillery and small-arms powders from which to select.

ASSEMBLY of these units will be dictated by their required juxtaposition and the permissible geometry of the complete assembly. Compatibility of the items with each other and with the assembly can be determined by known recorded characteristics. The assembly will have to be tested for performance under the required conditions and also under extreme conditions which might occur in their service use. The integrity, performance, and reliability of the individual units are already proved.

Thus, with the ability to make proper selection of the items needed and the ingenuity to adapt and assemble them, a seemingly difficult pyrotechnic design problem has been solved. The success of this design, its advantages, disadvantages, and behavior, will be recorded by the fact-finding agencies and made available to other contractors.

The missile-design companies seek to be as autonomous as possible in their design conception, development, test, and fabrication. The autonomy sought need not be compromised by the suggested approach; it is probable that the independence and success of the design company's pyrotechnic laboratory will be advanced as a consequence of "brain-picking" the special agencies.

Once the success of pyrotechnic design has been established, the designer will thereafter be most reluctant to sacrifice precious payload for heavy substitute devices.

Right, an Atlas ICBM roars off in test flight (Air Force photo).

Lightweight Armor

(Army photo)

George B. Bailey

IN 1854, Emperor Napoleon III ordered lightweight aluminum armor and military equipment for French troops. But the new metal in those days cost $545 a pound, and there just was not enough aluminum being produced to equip one squad, let alone an army.

Today, however, the U. S. Army is modernizing, particularly Ordnance vehicles and heavy weapons, by making lightweight air-transportable equipment from aluminum.

Reynolds Metals Company's recent "Survey of Aluminum in Defense" revealed that the Army Ordnance Corps now has twelve vehicles either in production or development, all using aluminum.

This survey showed that the armed forces are using more and more aluminum to get light, tough equipment. A minimum of 336 actual or potential uses of aluminum were discovered. The Army led the field with 255 types of equipment that are or could be made of the light metal.

This trend toward light equipment for better mobility started in 1952 when the first Army regulation was written on the subject. But little attention was given it until 1955 when the then Chief of Staff, Gen. M. B. Ridgway, wrote Army commands directing that all equipment must be as light and compact as possible. Yet very little lightweight equipment was produced then because aluminum was listed as a critical material until April 18, 1957. Since then, military designers have been turning out aluminum equipment in increasing quantity.

Mr. Bailey is manager of the Federal Government Liaison Division, Reynolds Metals Company, Washington, D. C.

More military equipment will be made from aluminum this year than ever before in history. And the variety and quantity of this type equipment will increase substantially in the next few years.

The Ordnance Corps leads with the most dramatic new uses of aluminum for arms—for example, the T195 self-propelled 105-mm. howitzer which is protected by aluminum armor plate giving about the same protection as steel armor, yet lighter. The aluminum armor plate and aluminum hull cut the weight of this combat vehicle until it weighs one-third less than its steel predecessor (33,500 pounds versus 53,000 pounds).

Although the vehicle has a lower silhouette, the cab has more space for the crew. The T195 can swim rivers and lakes. The howitzer can be fired while the vehicle is swimming so it can clear its own beachhead and not be dependent on other services for temporary artillery fire, and it can be transported by air to the battlefield for strategic mobility. Because it is lighter, the T195 goes farther on a gallon of fuel than the steel model.

ITS many advantages make aluminum the most economical and practical material to use for twentieth-century warfare. Defense designers have found that aluminum saves weight because it is one-third as heavy as steel and aluminum armor plate provides equal ballistic protection with less weight than comparable steel armor. This weight saving contributes to the air-transportability of armored combat vehicles, providing greater strategic mobility. Lightweight vehicles give better performance for the power expended and require less fuel than conventional vehicles.

Aluminum retains its impact resistance and does not shatter at extremely low temperatures, whereas most other metals lose much of their resistance to impact at the low temperatures encountered in the Arctic. Aluminum actually becomes stronger as the temperature drops.

Important to the taxpayer, defense official, and manufacturer is the economy of aluminum—it is readily available in plentiful supply, costs less to fabricate because it joins and forms easily, and requires far less maintenance than most other materials. It also has high reclamation value.

TODAY America can produce 2,230-250 tons of aluminum yearly, and the industry has further expansion plans. This is contrasted to the 719,000 tons produced in 1950, the year the Korean conflict broke out.

Mobility is the key word in the modern Army. Fighting men have to be able to move fast over every kind of ground and still have protection. The Army's Deputy Chief of Staff for Logistics, Lieut. Gen. Carter B. Magruder, told a congressional committee in 1958:

"Armor is critically important for mobility in atomic war. It may well be that nothing will move on the atomic battlefield except armor. Armor gives great protection not only against conventional weapons, but also against the blast, the heat, and the radioactivity of atomic bursts."

The Army's Deputy Chief of Staff for Research and Development, Maj. Gen. Robert J. Wood, told a congressional committee on June 23, 1958, that pigs protected from atomic blast and heat by aluminum cylinders during nuclear tests lived for two days to two weeks after the tests. He said: "One thing we learned from the standpoint of combat operations is this: if individuals are protected from heat and blast, subject only to radiation, while they might die in two days to two weeks, they could man their weapons in defense against an immediate attack."

Similarly, General Magruder told the House Appropriations Subcommittee on March 25, 1959:

"On the battlefield only armor or entrenchment give any reasonable degree of protection from atomic bursts. If we are not to resign ourselves to a static role, we must have armor. Atomic bursts not only kill or incapacitate by blast, heat, or direct radiation, they also fell trees, knock down buildings, crater the earth, and leave dangerous residual radiation. Atomics will be used against bottlenecks in the lines of communication and will destroy bridges and defiles.

"Our armored personnel carriers must, therefore, like the tank, be able to give protection against the blast and heat of atomic bursts and, in addition, have the mobility to cross piles of rubble, fallen trees, and craters and swim streams.

"Although the armor of an armored personnel carrier can be made only thick enough to give limited protection against direct and residual radiation, it will still be far safer than exposure in the open. The speed at which it can cross contaminated areas is also a significant means of protecting troops on the atomic battlefield. We have reason to hope that in the future certain medicines will give a considerable additional protection against radiation.

"In any armored vehicle the weight of the armor largely dictates the weight of the vehicle and greatly influences the size of the engine, the range of the vehicle, the gasoline consumption, and the capability of crossing frail bridges, swampy ground, rubble, and other difficult terrain features. The development of aluminum armor, together with changes in design and components, have permitted the weight of the vehicle to be cut in half while providing the same protection as the steel armor.

"This advance of major proportions gives our new M113 aluminum armored

Aluminum cargo carrier T116, amphibious replacement for the Weasel and Otter, rolls from C-124 transport plane (Army photo).

personnel carrier advantages over the steel-armored M59 personnel carrier with a decrease in weight from 21 tons to 10 tons, an increase in range from 120 to 200 miles, an increase in speed from 32 to 40 miles per hour, and an improvement in fuel economy from 1 mile per gallon to 2.6 miles per gallon.

"The greatly reduced weight has enabled us to replace two gasoline-driven engines in the M59 with one gasoline engine in the M113 with the resultant saving in maintenance. We expect eventually to power the M113 with a multifuel engine. . . . This will further increase the range of the vehicle."

MILITARY designers, like most people, have been hard to convince that aluminum armor plate gives equal or better protection than comparable steel armor. But this has been proved.

When you consider this question for a minute, you will see that it is perfectly logical. A piece of steel armor plate, one inch by one inch by one inch, will weigh three times more than an equal-sized piece of aluminum armor plate. The aluminum armor can be thickened until it gives the same protection as the steel armor, but the aluminum armor will still weigh less than the steel.

The aluminum armor can be made three times as thick as the steel, at which time both pieces will weigh the same, but the aluminum armor, while the same weight, will give better ballistic protection than the steel due to the increased thickness.

Thus aluminum armor can be used two ways in military equipment: to give the same protection as steel with much saving in weight or to give more ballistic protection than steel without increasing the weight of the vehicle.

Another advantage of aluminum is economy. The aluminum-armored M113 personnel carrier promises to be cheaper than its steel counterpart. Maj. Gen. Frederic J. Brown, Assistant to the Deputy Chief of Staff for Logistics, told the House Appropriations Subcommittee on April 18, 1958:

"We believe in the long run it (M113) will be a cheaper vehicle, although we are starting at the same price as our last procurement of the M59 (steel personnel carrier). The M59 is costing about $30,000, and this initial version will cost about $30,000."

Aluminum armor plate costs only slightly more than steel armor in the fabricated product. But the weight savings, the fuel savings, and other advantages can easily offset the slight additional cost in many applications.

FOR example, rust-free and corrosion-resistant aluminum equipment requires less maintenance than other materials; it is easier to store, even outdoors. Lighter weight equipment means longer life for engines and other parts. Vehicle sections can be made thicker and still lighter than steel, making them more rigid and reducing vibration.

On the battlegrounds of the future, fast-moving Ordnance equipment may not be able to use bridges which might be bombed out or make inviting targets for atomic weapons. Aluminum-armored combat vehicles can swim across inland waterways such as rivers, lakes, and canals with ease, thus avoiding the traffic bottlenecks of bridges.

Although it has taken over a hundred years—from 1854 till 1959—for aluminum to become vital for military equipment, there fortunately are thousands of fabricators of aluminum in all parts of the United States. Techniques and fabricating practices are well known for all types of products and methods. In case of an emergency, this army of skilled craftsmen and workshops is available to the military. They would not suffer from a shortage of metal either; since 1950, U. S. aluminum production has increased more than three times.

In addition to the T195 self-propelled 105-mm. howitzer, the Ordnance Corps is developing several other vehicles which rely on aluminum to save weight.

M113 Personnel Carrier.—Improved

Aluminum is used extensively on the ¾-ton cargo-personnel carrier XM433E1 built by Willys Motors and currently undergoing Army Ordnance tests.

design using aluminum armor plate helped cut the weight of the M113 in half compared with the M59, yet the aluminum M113 gives the infantryman approximately the same protection. The carrier is designed for better mileage, longer range, and is shorter, lower, and narrower, yet will carry as many men as the M59—an infantry squad of twelve plus the driver and vehicle commander.

The M113 can be carried in a cargo airplane, can be parachuted to the battlefield, and can swim inland waterways. While it was designed primarily to provide the infantry with armor-protected battlefield mobility, it also can be used as a multipurpose carrier, a self-propelled weapons carrier, a mortar carrier, ambulance, communications vehicle, command-post vehicle, cargo carrier, and fire-control direction center. (See photo on page 336.)

The M113 will be used by the infantry to move rapidly about in dispersed warfare and to have some protection against heat and blast from atomic explosions. A smaller aluminum vehicle, the T114, designed to carry four men, also is under development.

Aluminum Trucks.—The Army also is developing a family of lightweight trucks, using aluminum to make them air transportable, maneuverable, floatable, and rugged. One of these trucks, the XM410, is now undergoing tests.

It can travel across country, take to water like a boat, or be transported by air. It has eight wheels, all powered.

The new vehicle, rated at 2½-ton capacity, weighs only 8,600 pounds, about two-thirds the weight of the Army's present standard 2½-ton truck. This exceptional lightness, combined with a watertight body, permits the vehicle to float while carrying a 5,000-pound load, a decided military advantage. Its independently sprung wheels, with low-pressure tires, give the aluminum truck cross-country versatility approaching that of a tracked vehicle. Its compactness and lightness also make it readily transportable by existing military cargo planes.

The XM410 truck is a multipurpose vehicle. By altering the configuration of the body it can be a cargo carrier, gas tanker, mobile crane, ambulance, or missile launcher. The design principles embodied in it will also be incorporated in 4 by 4 (1-ton) and 6 by 6 (1½-ton) trucks. Prototypes for these are being developed by Chrysler corporation.

The Mighty Mite, ¼-ton all-aluminum truck, can be lifted by helicopter to beachhead (Marine Corps photo).

M56 Scorpion Self-Propelled 90-mm. Antitank Weapon.—This weapon uses aluminum to reduce its weight so it can be flown to the battle area. It can be parachuted or carried by a helicopter. It is operated by a crew of four men: commander, driver, gunner, and loader. The Scorpion is now operational in U. S. Army airborne units.

XM443E1 Cargo-Personnel Carrier.—This lightweight tactical vehicle, being investigated experimentally by the Army, made largely of aluminum, is known as a "platform vehicle" because it consists of a platform with wheels. The cowl can be taken off, four of the six seats folded down, and it becomes a cargo carrier. Mounted under the platform, a 100-horsepower, air-cooled, aluminum engine gives the XM443 a top speed of forty-five miles an hour on the highway.

It has a 4-wheel drive and can maneuver over fields as well as on roads, even climbing up to 60 per cent grades. Individual wheel suspension gives comfort to passengers and protection to sensitive equipment riding over rough terrain.

This vehicle is presently being evaluated to determine the suitability of the platform-type carrier for larger payload ratings than that of the present Mechanical Mule and also to determine if the concept of the convertible platform has sufficient merit to justify further development.

M274 Mechanical Mule.—The Mechanical Mule weighs 950 pounds but can carry 1,000 pounds on its platform. Designed to take the load off the infantryman's back, it can go anywhere, even climb sixty per cent grades. The Mechanical Mule is meant to be used off the road, rather than on paved highways, therefore its top speed is about twenty-five miles an hour. It can ford streams up to eighteen inches deep and turn in a 10-foot radius, its own length.

The driver can either sit on the seat or walk behind the vehicle to lower the silhouette. The steering column may be lowered, enabling the driver to crouch low to the ground as he moves the vehicle forward. In addition to carrying ammunition and weapons, the Mechanical Mule can evacuate four wounded, which would normally require sixteen stretcher bearers.

With a 106-mm. recoilless rifle mounted on the platform, the Mechanical Mule can support an antitank mission with fast maneuverability. It has both 4-wheel drive and 4-wheel steering.

T116 Cargo Carrier.—This aluminum vehicle is the amphibious replacement for the earlier Weasel and Otter vehicles that cross mud and snow. The T116 is air transportable and is designed primarily to carry cargo and loads over difficult terrain, especially snow.

Countdown at Canaveral

Missile launching needs the cooperation of industry and the services

Col. Leonard M. Orman, U.S.A.F.

WITH moon shots, earth satellites, intercontinental ballistic missiles, intermediate-range ballistic missiles, and other accelerated missile programs, Cape Canaveral makes headlines with awesome regularity.

Although newspaper reporters give Cape Canaveral datelines in filing stories, and it is from there that all the Atlantic Missile Range missiles are fired, the headquarters is at Patrick Air Force Base—eighteen miles south of the Cape proper. During World War II, Patrick Air Force Base began as the Banana River Naval Air Station. It was closed at the end of the war and reopened in 1951 as the Joint Long Range Proving Ground, encompassing about 12,000 acres.

The first missile fired was a Bumper —a V-2 plus a Wac Corporal. Since most of the work there was being done for the Air Force, it became the Air Force Missile Test Center; but when interest increased in longer-range ballistic missiles, the other services began to move back. The Army came first with Redstone, followed by Jupiter. With the International Geophysical Year the Navy brought in its Vanguard and, soon afterward, the Polaris. Concurrently, the Air Force was establishing many new programs of its own, including Thor, Atlas, and Titan.

TO gain a true picture of life at Canaveral, both behind the scene and on the scene, let's follow the trail of an Army missile from arrival to launching on a typical time schedule.

X minus 20 days.—The first stage of a Juno (moon shot) or an Explorer (earth satellite) arrives by C-124 from Huntsville, Ala. The first stage has been built and static-fired at the Army Ballistic Missile Agency in Redstone Arsenal. The Missile Firing Laboratory, headed by Dr. Kurt Debus, takes the missile from the airplane to an assembly building at Cape Canaveral. Here the missile undergoes a thorough check-out of all its components, including the guidance system. At the same time, the upper stages are being tested by the Jet Propulsion Laboratory in a spin-test facility.

X minus 10 days.—The missile is moved to the launching pad and all the stages are "married" for the first time. A series of over-all tests and frequency checks occupy the final few days.

X minus 1 day.—The time for a preflight countdown. This is a dry run, and each of the staff who takes part in the final launching meticulously checks on his individual portion of responsibility, with the countdown coordinator checking all operations from the blockhouse. Of major concern at this time is the possibility of frequency interference because of the many electronic systems which are used for safety purposes as well as for commands and instrumentation.

X minus 6 hours.—The actual countdown begins. Many of the larger missiles are launched at night because the most accurate means of instrumentation, even in this electronic age, is a camera which can be oriented precisely only by positioning on a background of the stars both before and after a shoot. The firing time for moon shots depends on the relative positions of the earth and the moon.

X minus 3 hours.—Fueling starts. Several hundred people are at their positions, readying all their equipment for the final moment. Fifty people are assembled in the blockhouse, and others are at the actual launching pad. The missile is launched by controls within the blockhouse and some of the recording instrumentation, such as the scales which weigh the missile after it is fueled, are also located there.

KEY people from the range remain in Central Control which is located several hundred yards from all the blockhouses. The safety officer with his power of life or death over the missile reads a myriad of instruments.

Visual observers, on sky screens, radar indications on beacons, direct-viewing television cameras, and other electronic devices are the information sources for the safety officer's final decision. One of the most useful of these devices is Azusa which, when used with an IBM 704 predictor, tells the safety officer where the missile would land if he pressed the destruct button at that instant.

X minus 2 hours.—Frequency checks are being run—a vital part of the entire operations which makes sure that no data are lost. The safety officer makes sure that there is no interference with his destruct system. Interference could render the system inoperative and might even destroy a good missile prematurely. Interference comes from

Colonel Orman was formerly chief military officer of ABMA at Patrick Air Force Base, Fla. He is currently assigned to the Pacific theater.

many sources, a number of which are beyond control. It could be lady taxicab dispatchers in Dallas, television stations in Detroit, ships at sea, or radio broadcast stations in Brazil.

Some sources of interference have been traced to Eglin Air Force Base, Newfoundland, or the White Sands Missile Range, and here it was possible to work out a system of mutual use of frequencies or to shift to another frequency when necessary.

X minus 1 hour.—All tracking stations are manned and cameras are trained on their subject. These cameras fall into three categories which may be called historical, metric, and ballistic. Within each category are many different types—still, color, black and white, and movie cameras operating at various speeds.

Timing is available to an accuracy of a thousandth of a second. A ballistic camera is composed of two or more metric cameras, positioned on surveyed base lines so that it is possible to locate the position of the missile in space in two or more coordinates.

CAMERAS and electronic tracking are manned at stations all over Florida as well as at many down-range sites. Station No. 1 is Cape Canaveral itself. No. 2 is at Jupiter inlet a few miles south on the Florida coast. No. 3 is at Grand Bahama Island. No. 4 is at Eleuthra Island. No. 5 is at Christopher Columbus' landfall—San Salvador. No. 6 is at Mayaguana. No. 7 is at Turks and Gacios Island. No. 8 is on the Dominican Republic half of Hispaniola. No. 9 is on Puerto Rico, No. 9A at Antigua, No. 10 at St. Lucia, No. 11 at Fernando de Noranha off the coast of Brazil, and No. 12 at Ascencion Island, halfway between Africa and South America.

Since most of these stations are on British possessions, the commander of the Air Force Missile Test Center has an RAF officer on his staff to assist him in day-to-day negotiations with local British authorities.

X minus 30 minutes.—All people in the vicinity of the launch pad take cover in the blockhouse and Central Control consoles are manned. The safety officer and his assistants are ready and have their circuits checked, and a weather officer is on duty throughout the countdown. The console for frequency interference monitoring is manned. All cameras, radars, telemetering stations, and other electronic tracking and recording devices are ready and waiting. These vital telemetering instrumentation devices are the mechanical eyes and ears of a scientist which measure and broadcast back parameters such as speed, fuel levels, positions of gyros, and temperatures at critical points.

X minus 15 minutes.—The orderly step-by-step check-off continues and the point of no return is reached with some missiles. Others can be stopped at any time up to zero, and with still others it can be stopped within a second or two before actual take-off if indications are not reading as expected.

X minus 1 minute.—A final reading of the fuel aboard the missile is taken. The last item is checked, and the countdown director receives an okay or roger from all the staff concerned before he gives his final command.

X minus 10 seconds.—The pressurization button is pushed.

X plus seconds.—For a few long seconds after zero nothing seems to happen. Then a flame shoots out from beneath the missile. The dry ice which has been cooling the batteries in the instrumentation compartment falls with a crash. The giant rocket slowly begins its skyward journey. It gains speed. The roar reaches over the beachside spectators. After a vertical rise of several thousand feet, the missile programs over and steers out to sea to travel along the chain of Caribbean tracking stations.

X plus several dozen seconds.—Cutoff occurs. The flame from the motor extinguishes itself. The upper stages now coast on beyond the control of man.

No one sits at a device on earth and guides the missile through space to its target. A tape has been cut for its flight path and placed in its guidance system before take-off. Deviations from the established path are noted and measured by the missile's sensing devices, and these deviations are automatically corrected throughout the flight of the final stage.

X plus several minutes.—The upper stages are fired. The increased speed is measured and the collected data are fed into computers to see if escape velocity and orbit are obtained. In the case of a lunar shot, the proximity of the final path to the moon 2½ days later is read out.

"Interference could render the system inoperative and . . . interference comes from many sources, a number of which are beyond control. It could be lady taxicab dispatchers in Dallas, television stations in Detroit, ships at sea, or radio stations in Brazil."

THE casual observer may carry away an erroneous impression of the work of Patrick Air Force Base. A missile which does not travel its entire preassigned path is frequently labeled as a failure and a total waste. Only the experienced person can explode this popular fallacy. Paradoxically, often more is learned from the missiles which appear to end in spectacular explosion than from a routine flight.

Another false impression is that missiles can never be made operational because of the size and complexity of the launching facilities and because of the high education and experience level of the launching crews.

A concrete answer to many of these fallacies is supplied by the Redstone. This missile can withstand weather of considerable severity and high-velocity winds. Many of the holds in the countdown at Canaveral are for instrumentation purposes and would not occur in the field. The programming equipment for field use can be carried on a truck along with the erecting equipment, and soldiers with only a few months' training have fired the missile.

THE "bitter" rivalry that is supposed to exist among the military services and the contractual companies has no place on the actual working level of the missile range. It takes the wholehearted participation of the Army, the Air Force, Pan American World Airways, the Radio Corporation of America, and the civil-service employees of both military services to ensure a successful lunar probe or satellite shot. And it is only through this spirit of harmony that the United States is making giant steps toward world supremacy in space, as seen from behind the scenes at Cape Canaveral.

Vehicle Reliability

Recommendations of the A.O.A. Combat and Tactical Vehicle Division

E. J. Gay

THE Combat and Tactical Vehicle Division of the American Ordnance Association met recently in Detroit, Mich., to discuss the subject of improved reliability and reduced field maintenance of combat and tactical vehicles. Representatives from both the military and industry were present, and the numerous papers and discussions disclosed that, in general, there was agreement between industry and the military as to the steps required to reach the desired objectives.

Maj. Gen. Nelson M. Lynde, Jr., in opening the meeting, stated that future wars will require a degree of mobility and dependability beyond anything we have previously attained. The general gave as a target a 90 per cent probability of achieving the following:

For Wheeled Tactical Vehicles.—By 1960-1963: 10,000 miles without field maintenance, 20,000 miles without depot maintenance; by 1964-1970: 25,000 miles without field or depot maintenance.

For Tracked Vehicles.—By 1960-1963: 2,000 miles without field maintenance, 4,000 miles without depot maintenance; by 1964-1970: 5,000 miles without field or depot maintenance.

Current information indicates that the best current wheeled vehicles have a 42 per cent probability of completing 20,000 miles without rebuild of components; tracked vehicles have a 3 per cent probability of reaching 4,000 miles without the failure of a major component.

Arch T. Colwell, in his keynote address, outlined many important points including the following:

1. The military problem of rotation and early retirement of officer personnel makes for lack of continuity of programs.

2. To achieve the desired targets, team effort by industry, the Continental Army Command, and the Ordnance Tank Automotive Command will be required. Adequate funds and understanding in high places also are needed.

3. A clear exposition of what the military wants and how they will test it is needed. When this is available, industry can work toward a solution.

4. A new style in military vehicles every few years does not make for good reliability. Industry rarely brings out a vehicle having all new components.

Mr. Gay is chairman of the Engine and Power Train Section of the A.O.A. Combat and Tactical Vehicle Division.

THE papers read at the meeting discussed a number of problems and made certain recommendations for their solution. Some of the more important of these are outlined below:

1. Development and testing of new vehicles should be more sharply defined so that the objectives of the military are clearly appreciated by industry. It should be understood by both the military and industry that vehicles released for production will pass these tests satisfactorily.

Recommendation: A study panel of seven be established to set up test procedures, acceptable to both the military and industry. The panel would consist of three industry representatives and three military—with the military supplying one each from OTAC, CONARC, and Fort Knox. The seventh member would be from the Finance Office, Office of the Secretary of Defense.

2. More time should be allocated for the preproduction development of components and complete vehicles. This is the era of major "debugging" and will assure a more satisfactory vehicle in the hands of the using service.

Recommendation: This need for development and testing of components and vehicles should be recognized and the necessary funds provided in the contract to permit adequate development.

Military vehicle components and parts must accomplish their mission in a military environment which can be markedly different from commercial usage. In the designing of military equipment, every effort should be directed toward maximizing the employment of commercial tooling and facilities.

This doesn't always mean that commercial parts, *per se*, will meet the military requirement. However, satisfactory parts can be obtained with a minimum of change to commercial tooling.

3. There is a practicable limit to the versatility of a tactical vehicle. It appears that best vehicle types are not obtained by trying to combine in one vehicle all the requirements of an airborne vehicle and a completely satisfactory vehicle for Arctic use. A great

penalty per pound is paid when air transporting vehicles. It is estimated that about 2½ pounds of fuel are required for each pound of payload transported 2,500 miles.

Recommendation: Serious consideration should be given to the development of a special group of lightweight tactical vehicles for airborne and Arctic use. This would permit the normal tactical vehicle to be developed for maximum service along the lines desired by the military.

4. Extra safety factor in components make for longer life of the complete vehicle.

Recommendation: This important point should be made familiar to military and Government personnel. Extra power and capacity in engines, transmissions, axles, etc., will result in greatly improved life. The additional first cost should be repaid many times in better field service.

5. Small items on a vehicle such as controls, linkages, instruments, and accessories cause a large percentage of failures. In many cases better equipment is available from commercial components but is not used because of an extra cost penalty. In the case of a combat-vehicle engine costing several thousands of dollars and a total vehicle cost of well over $100,000, economies on these small items appear to be penny-wise and pound-foolish.

It is questionable that vehicle styles need changing every few years and that the large variety of standard type vehicles are essential.

Recommendation: Coordination among the military services should attempt to freeze a few approved designs and thus permit these vehicles to develop by incremental improvement through field experience. This is the normal route followed by industry. Every effort should be made to keep vehicles as simple as possible since complication will then decrease reliability. Each added requirement of a vehicle should be given the most careful scrutiny to be sure that it is essential to the mission of the vehicle.

All new vehicle designs, both wheeled and tracked, should be studied by a qualified panel of industry and military for accessibility of parts for service and the probability of trouble because of field failure or lack of maintenance. Designing more durability into a vehicle should be a paramount item from the start.

A new program should be immediately established to find sources of adequate dust and grease seals. If such seals are not available, funds should be provided for their development.

6. Mobility requirements should be examined in relation to the vehicle's ability to carry a useful load. There is a practical limit to this item in relation to vehicle type. Vehicles with a high mobility factor will, of necessity, have to be kept light. There is need for a compromise between ground clearances and total height of the vehicle. The demand for low silhouettes can penalize a vehicle's mobility by forcing too low a ground clearance.

7. Military tactical vehicle requirements for brakes are many times more severe than for normal "on-road" commercial vehicles, and for that reason commercial brake systems are not satisfactory.

Recommendation: Special designs of waterproof, dirtproof brakes should be evolved and adapted to tactical vehicles for immediate and future procurement. Recent developments in vehicle brake retarders should be fully exploited.

8. Existing OTAC proposals for improved collection of field data are moves in the right direction. It must be recognized that there is a responsibility for accurate data collection in the field that is an Ordnance function rather than a field-troop function. This is a basic requirement toward attaining best product reliability.

Recommendation: Prompt action should be taken to implement a new and modernized system of data collection. This is best done by trained civilian personnel using modern data-processing equipment. Industry and the military should agree on a code for reporting troubles so that everyone is using a common language. It is essential that this collection of field data have the fullest support from all levels of the Army.

9. There are many areas where "throwaway" parts will simplify and expedite field maintenance. This is particularly true of items such as fuel pumps, instruments, seals, and many others. To make this system effective requires standardization of mounting brackets, fittings, etc.

Recommendation: This is an area where industry and the military can work together to develop a code of standard mountings, fittings, and performance specifications that would improve the ease of field maintenance.

10. Too often programs are stopped either for lack of funds or because of indecision on the use of the item. This is wasteful in manpower and money and sometimes results in a "crash" program to put a vehicle into production without adequate development and testing.

Recommendation: Every effort should be made to provide continuity of program, thus making best use of funds, time, and manpower.

11. Corrosion prevention, storage, and preservation of vehicles become highly important items when large numbers of new vehicles are stored.

Recommendation: Additional emphasis should be placed on the preservation and storage problem, and every effort should be made to have all military fuels and lubricants contain some measure of rust and corrosion prevention.

12. Steps are now in process to reduce the amount of maintenance done on military vehicles. It is the feeling of industry that in the past the military has overmaintained its equipment. The philosophy should be to let them alone to an absolute maximum degree, thus developing realistic experience factors on the life expectancy of equipment. Industry experience has shown that opening up equipment in the field can, and does, reduce the remaining life of the item by a factor of fifty per cent. The driver should do all first- and second-echelon maintenance with some small aid from assigned Ordnance personnel.

Recommendation: It is important that this item of reduced field maintenance be given the fullest support. It is a changing philosophy that may take firm action from the top to effect concurrence in the field.

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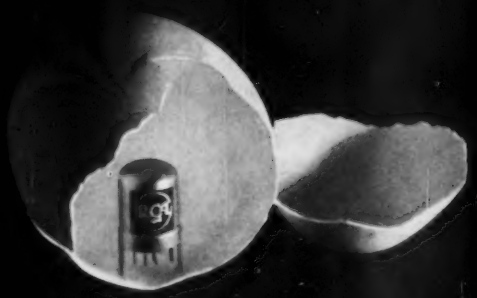

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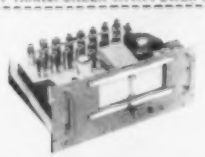

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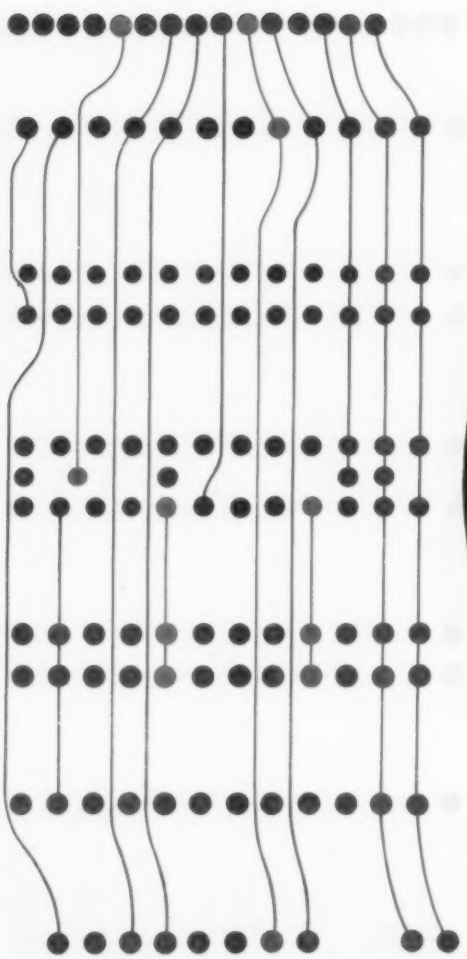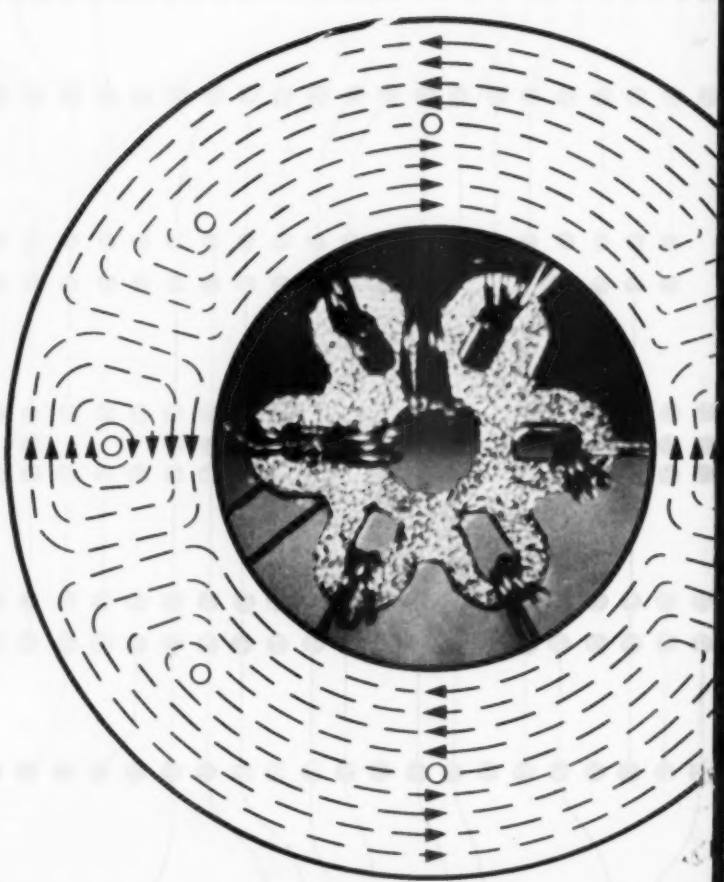
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